US006298778B1

(12) **United States Patent**
Onodera et al.

(10) **Patent No.: US 6,298,778 B1**
(45) **Date of Patent: Oct. 9, 2001**

(54) **SHEET FEEDING DEVICE FOR A PRINTER**

(75) Inventors: **Takayuki Onodera**; **Hideki Asai**, both of Miyagi (JP)

(73) Assignee: **Tohoku Ricoh Co., Ltd.**, Shibata-gun (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/432,222**

(22) Filed: **Nov. 3, 1999**

(30) **Foreign Application Priority Data**

Nov. 10, 1998 (JP) 10-319378

(51) **Int. Cl.**^{7} **B41F 13/24**; B41F 5/00; B41L 13/04; B65H 1/00; B65H 5/34

(52) **U.S. Cl.** **101/232**; 101/216; 101/116; 101/118; 271/10.05; 271/10.12; 271/10.13; 271/161; 271/270

(58) **Field of Search** 101/116–118, 216, 101/232; 271/4.1, 4.03, 9.01, 9.06, 9.09, 9.13, 10.03, 10.05, 10.11–10.13, 110, 111, 114, 161, 259, 265.02, 270; 400/605, 624, 625

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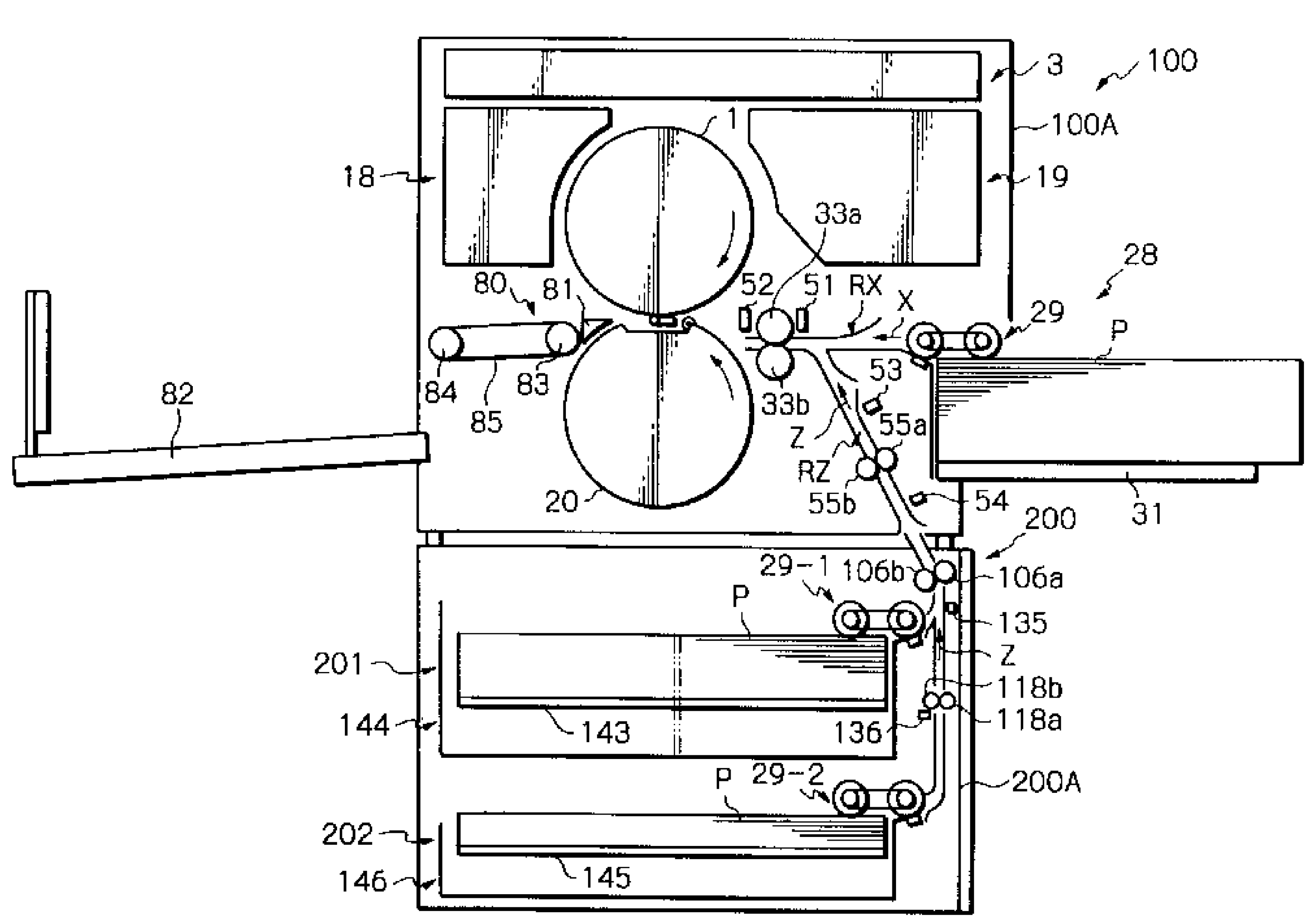
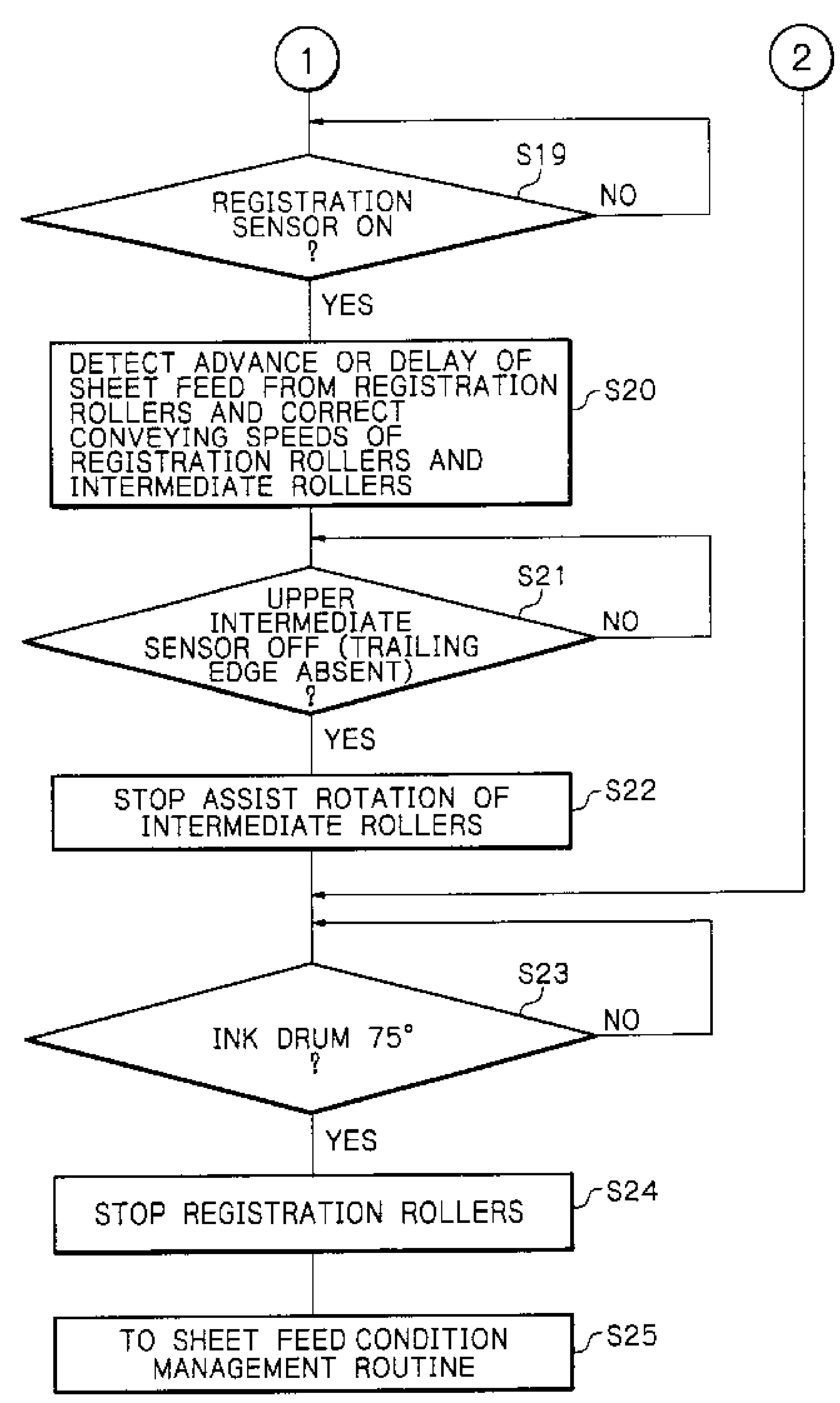
Primary Examiner—Kimberly L. Asher
(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

(57) **ABSTRACT**

A sheet feeding device for a printer, e.g., a stencil printer including an ink drum with a master wrapped therearound and a press drum one of which is pressed against the other during printing is disclosed. The sheet feeding device is capable of feeding a sheet at a preselected speed without regard to a print speed varying every moment due to various factors particular to an ink drum driveline, i.e., whether a set print speed is higher than a standard print speed or lower than the same. This successfully obviates the short loop of a sheet which would result in a skew or a feed failure. In addition, the device reduces noise at print speeds lower than the standard print speed and used more often than the other print speeds.

27 Claims, 35 Drawing Sheets





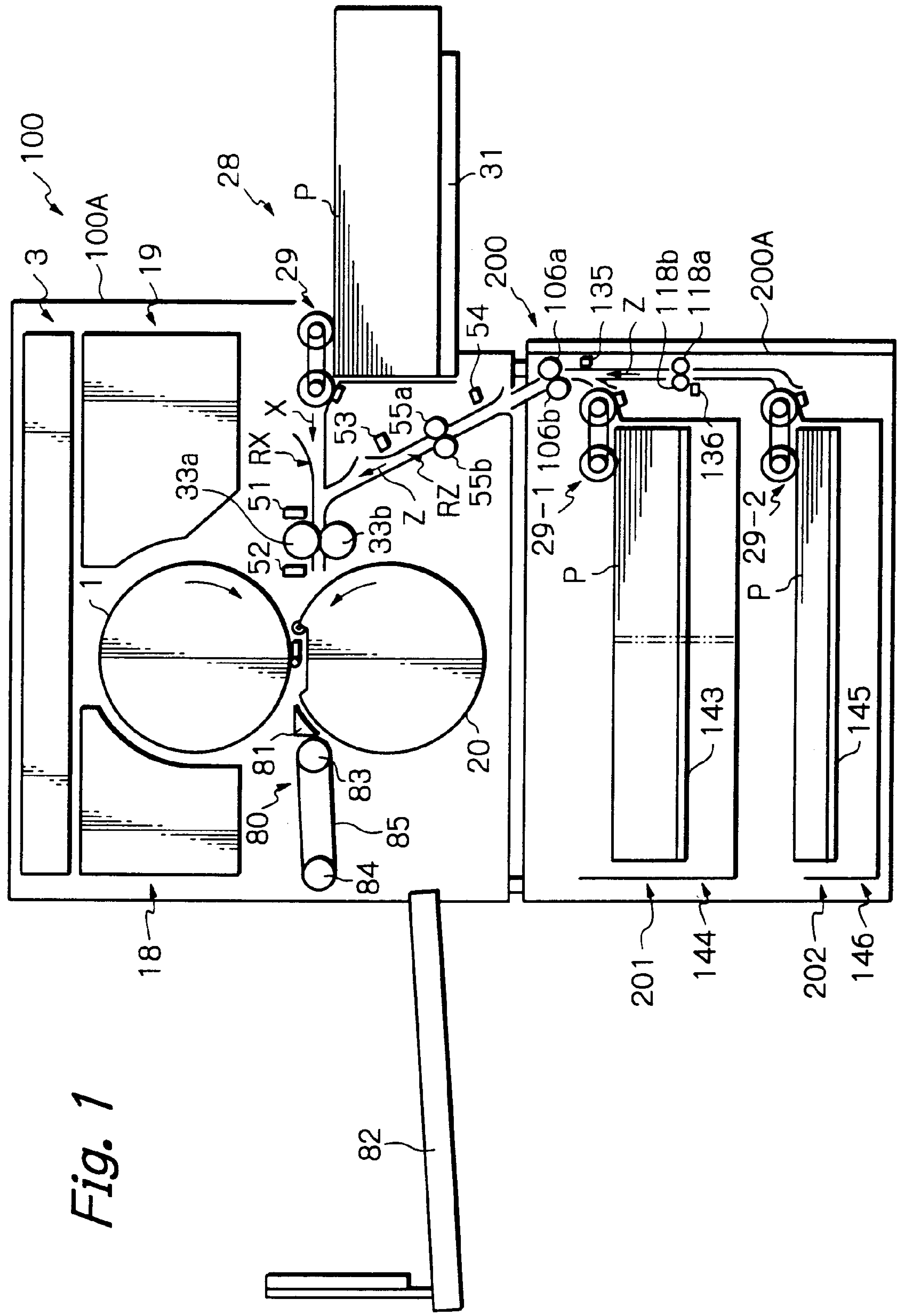

100
100A
3
19
28
P
31
29
200
106a
135
Z
118b
118a
200A
54
X
53
55a
51 RX
33a
52
33b
Z
RZ
55b
106b
136
29-1
P
29-2
P
1
20
81
83
80
85
84
143
145
18
201
144
202
146
82

Fig. 1

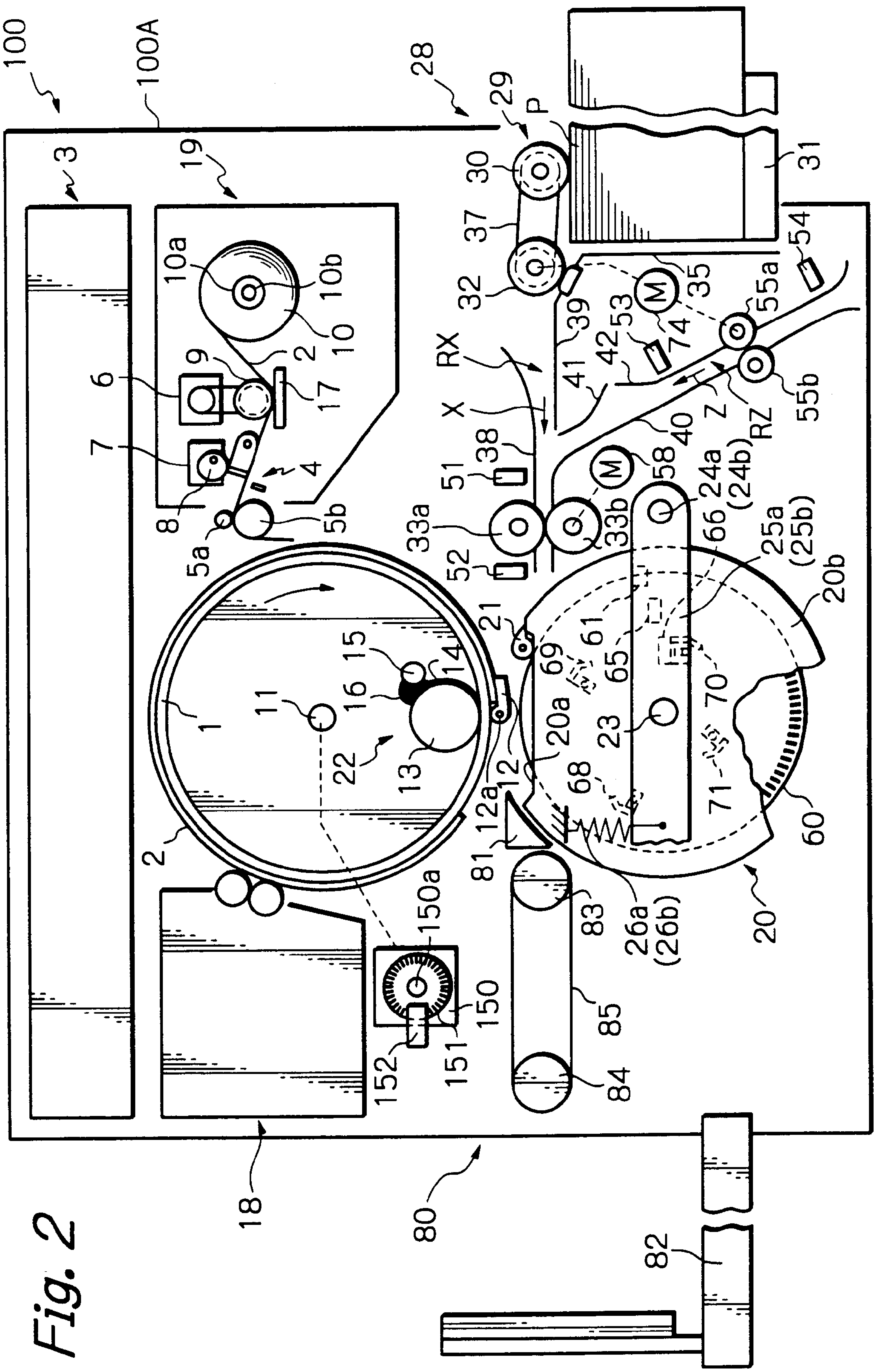

100
100A
28
29
P
30
31
37
32
35
54
3
19
10a
10b
10
2
9
17
6
7
4
8
5a
5b
RX
X
39
41
42
53
M
74
55a
55b
Z
RZ
40
38
51
58
24a
(24b)
33a
33b
66
25a
(25b)
52
21
61
65
20b
15
16
14
11
1
69
70
20a
23
22
13
12
12a
68
71
60
2
81
83
26a
(26b)
20
150a
150
151
152
85
84
18
80
82

Fig. 2

Fig. 3

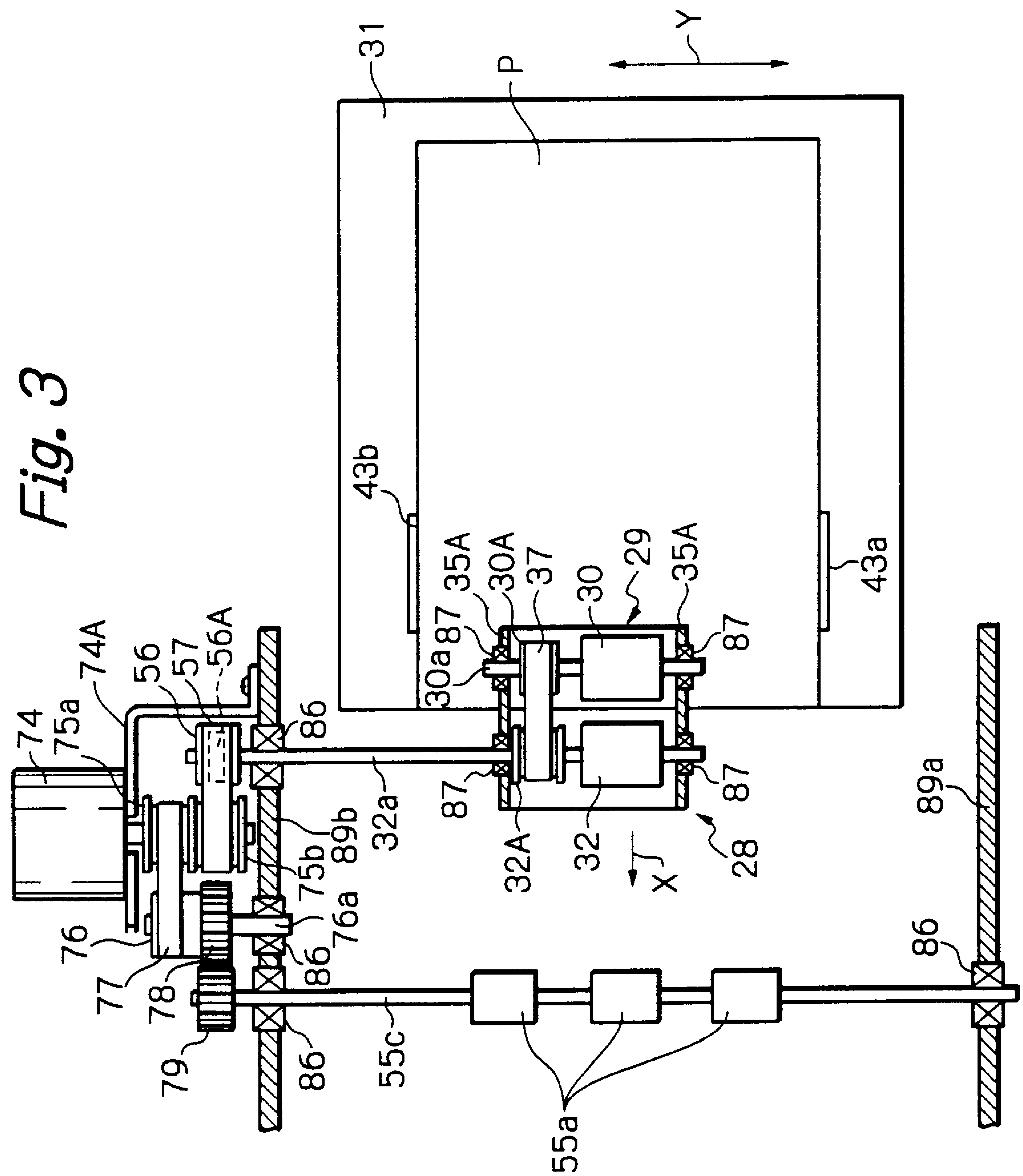
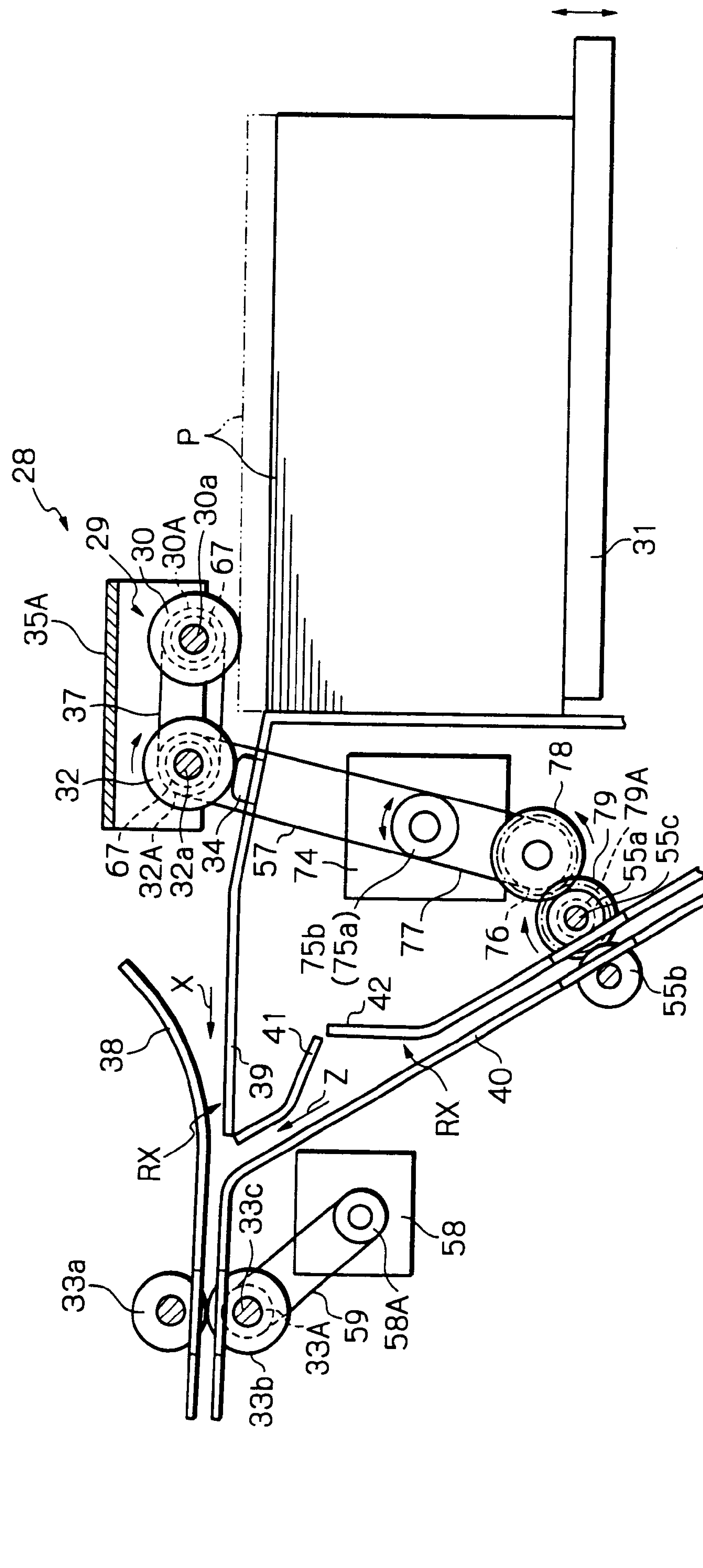

31
P
Y
43b
43a
29
30
37
30A
35A
87
30a
28
32
32A
32a
X
74
75a
74A
56
57
56A
86
89b
75b
76a
76
77
78
79
55c
55a
89a

Fig. 4


28
29
30
30A
30a
67
35A
37
32
67
32A
32a
34
57
74
78
79
79A
55a
55c
75b
(75a)
77
76
55b
P
31
X
38
39
41
42
Z
RX
40
RX
33a
33c
58
33A
59
58A
33b

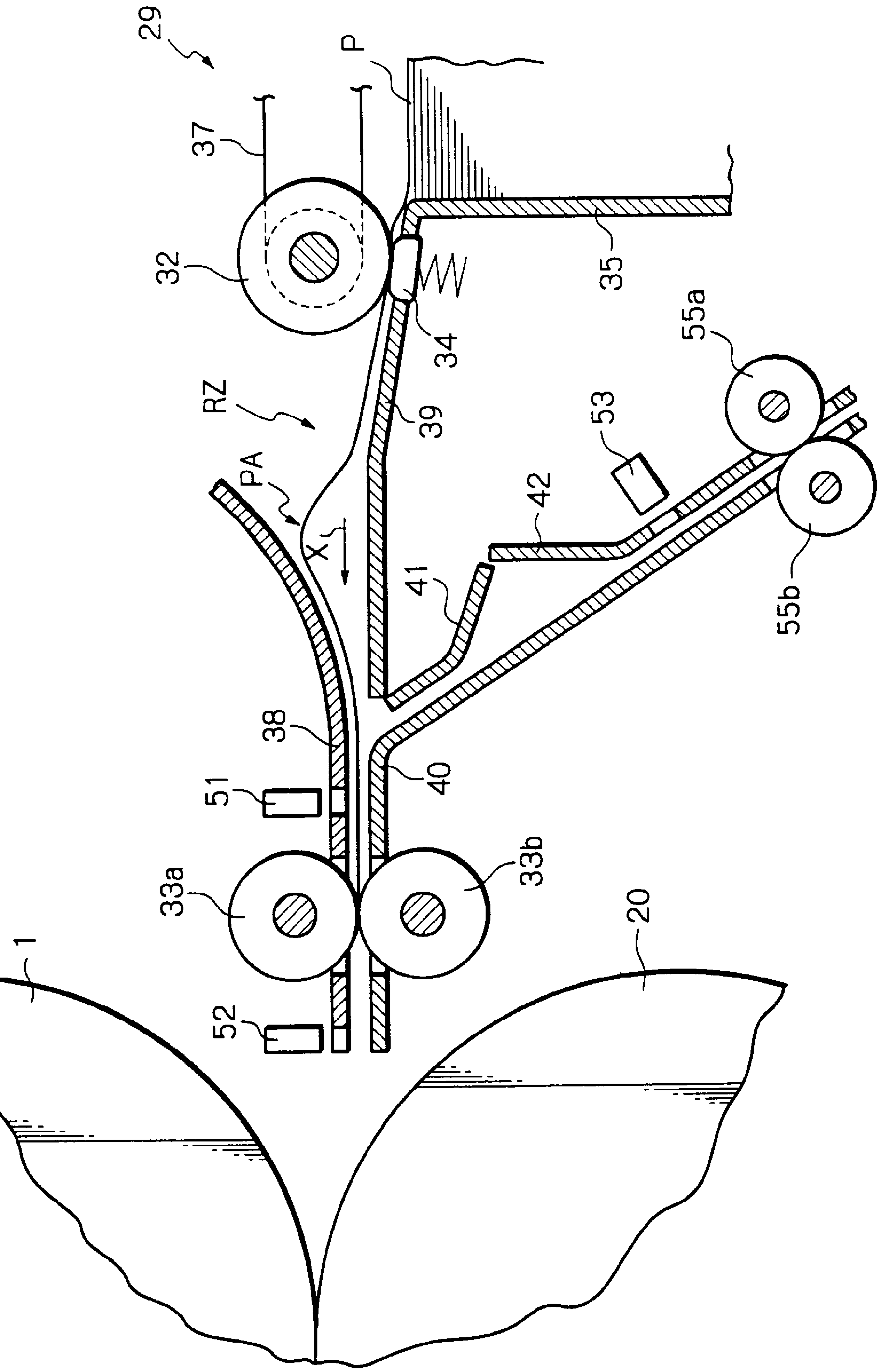


Fig. 5

Fig. 6

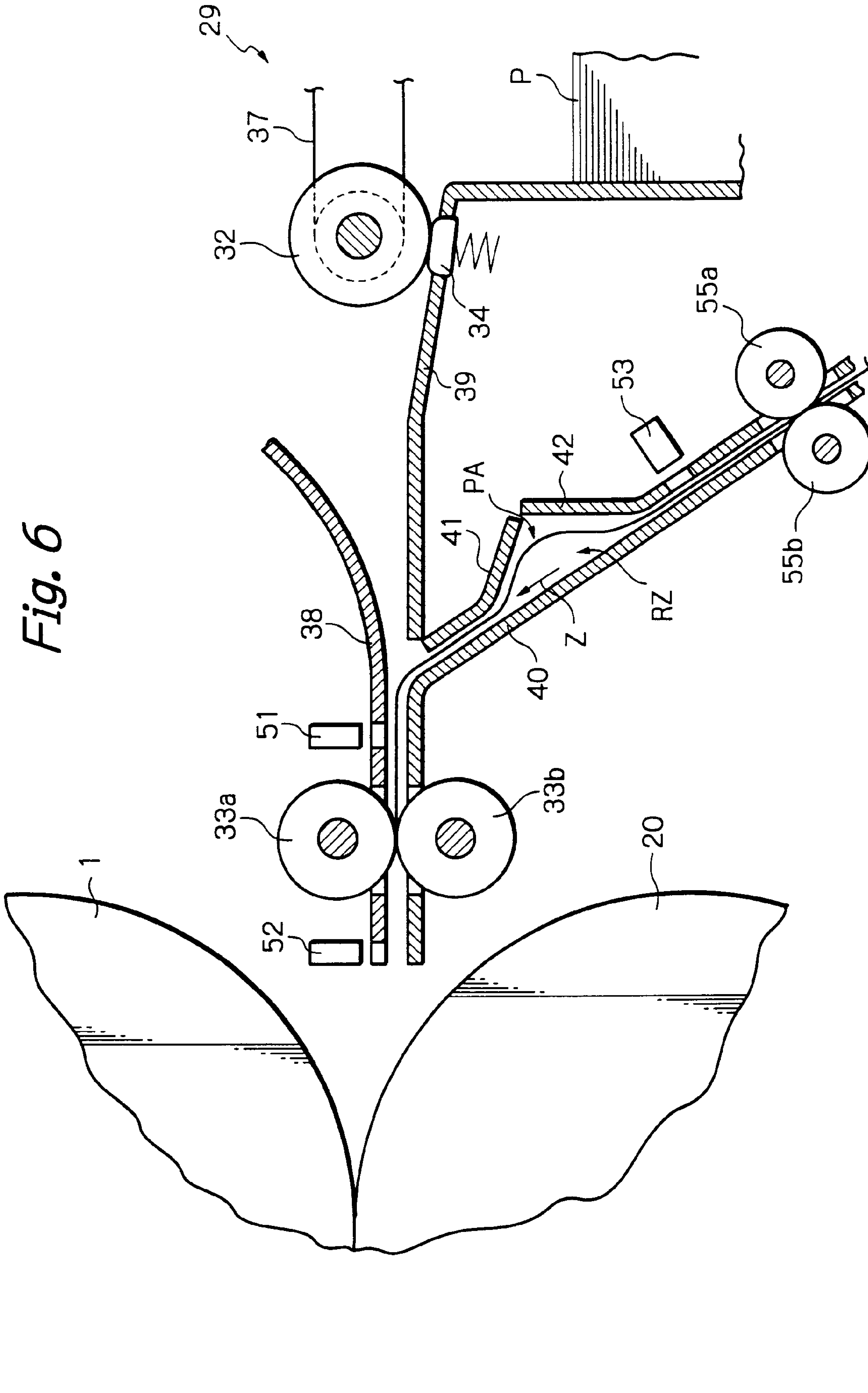
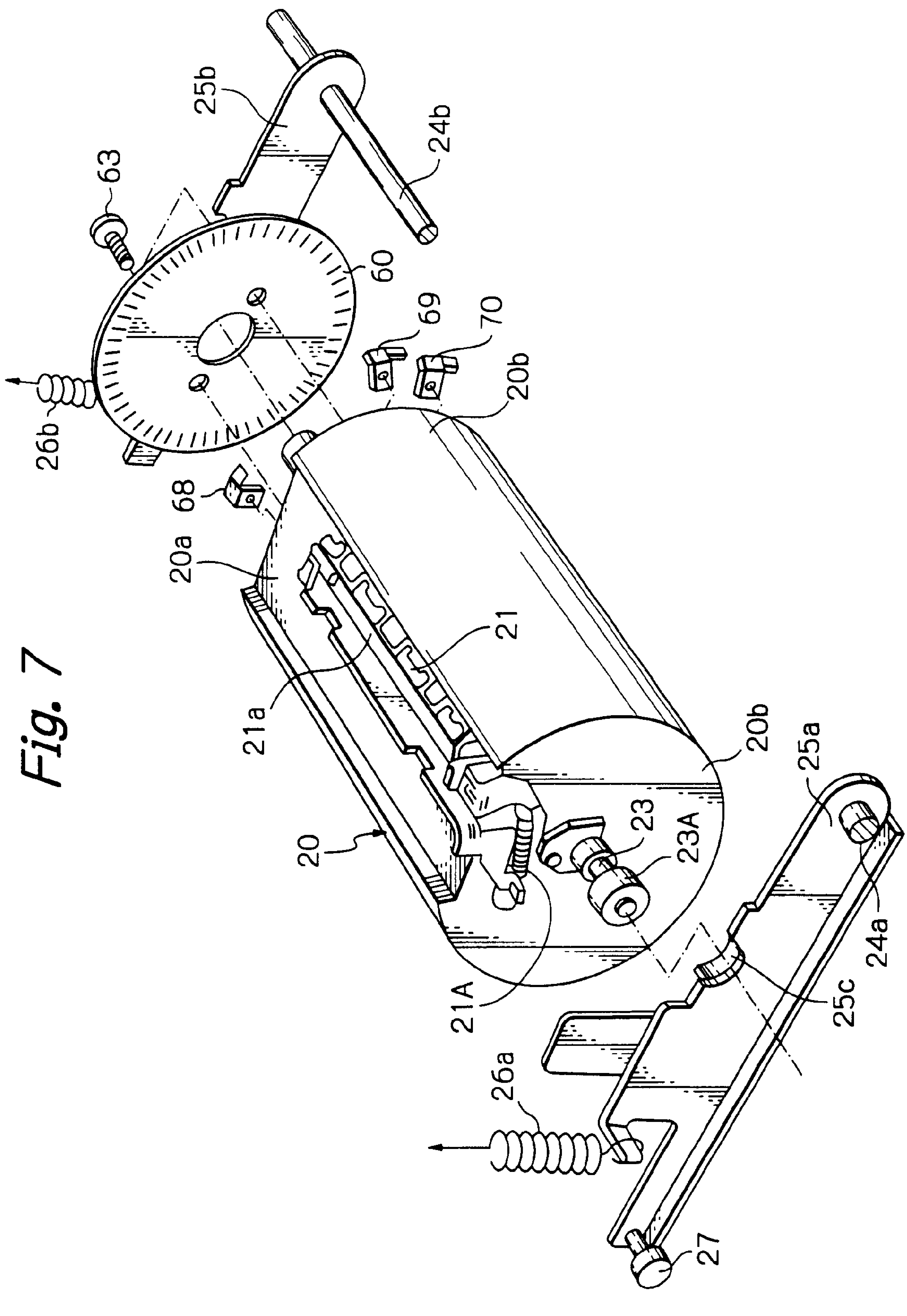


Fig. 7



25b
63
24b
60
69
70
20b
26b
68
20a
21
21a
20b
25a
23
23A
20
24a
25c
21A
26a
27

Fig. 8

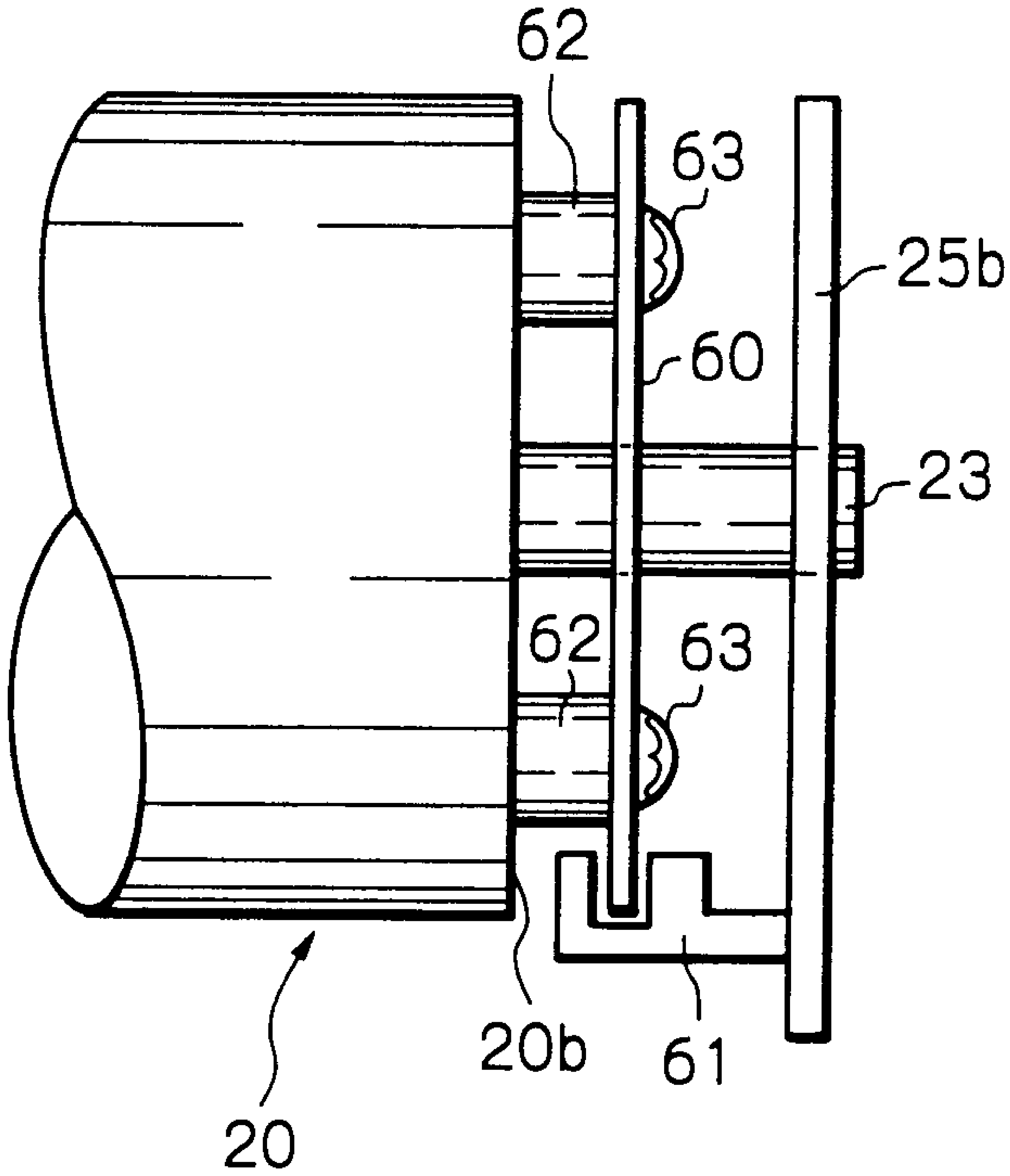


Fig. 9

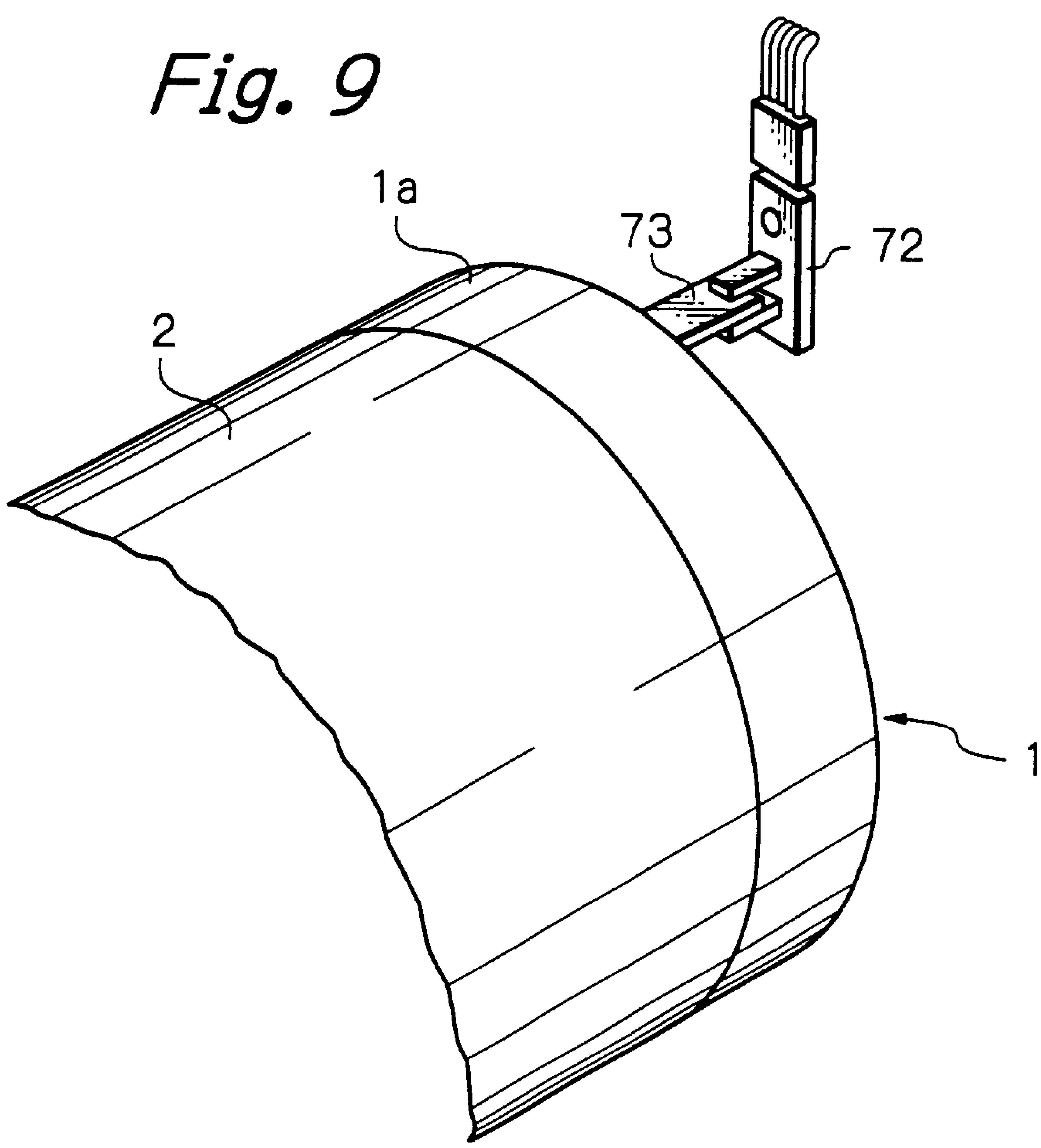


Fig. 10

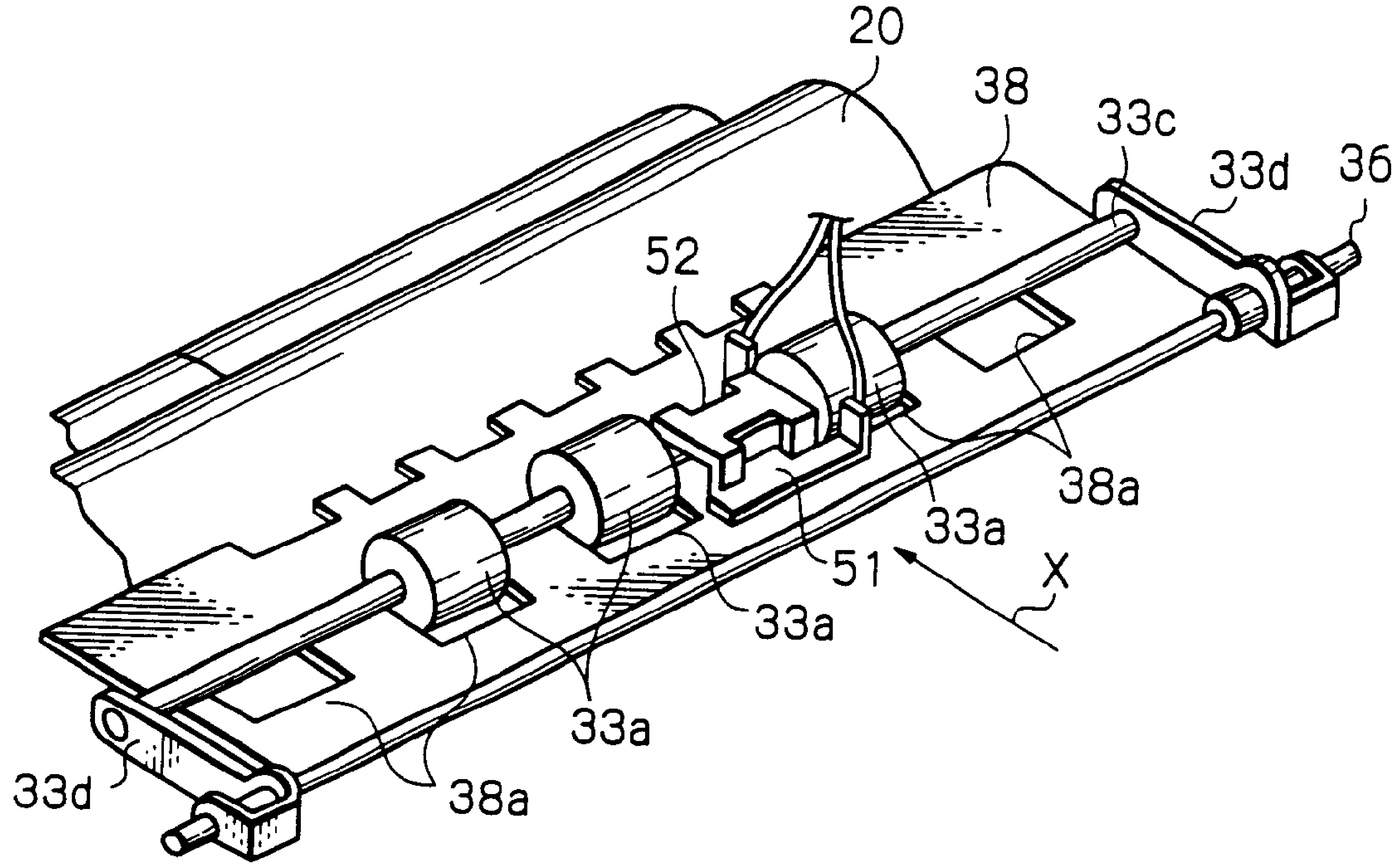

20
38
33c
33d
36
52
38a
33a
51
X
33a
33a
33d
38a

Fig. 11

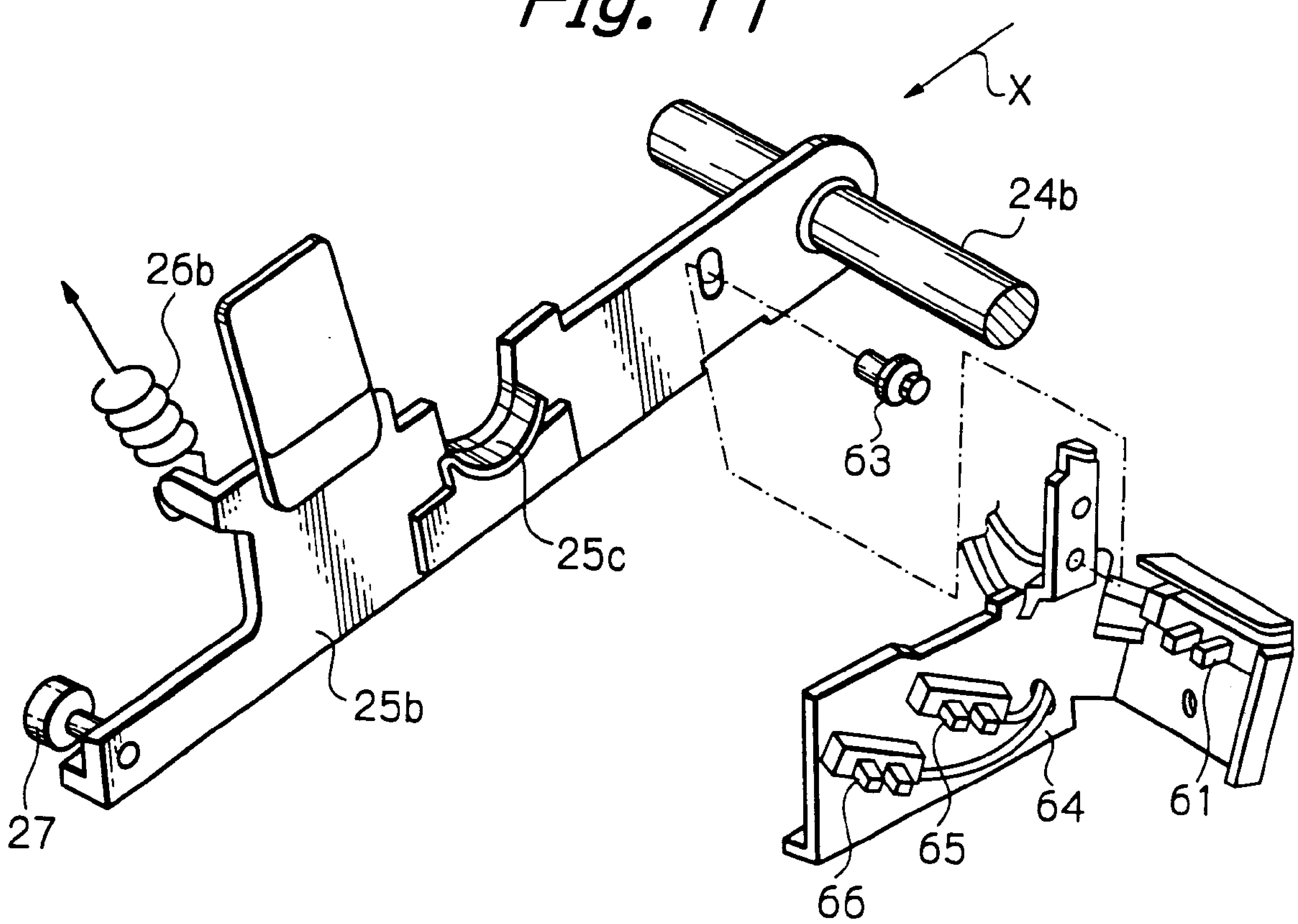

X
24b
26b
63
25c
25b
27
66
65
64
61

Fig. 12

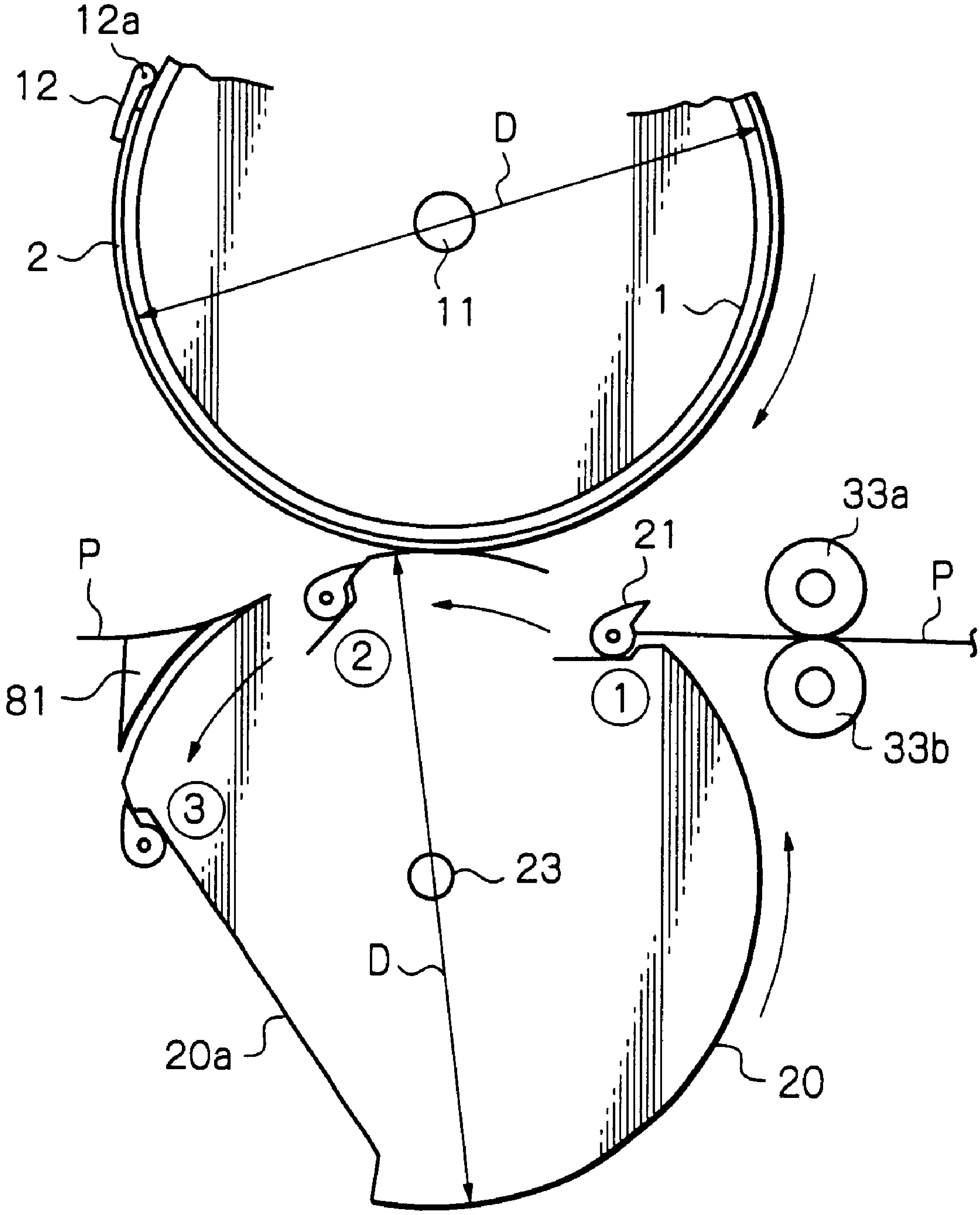


Fig. 13B

PRESS DRUM POSITION OF 194°

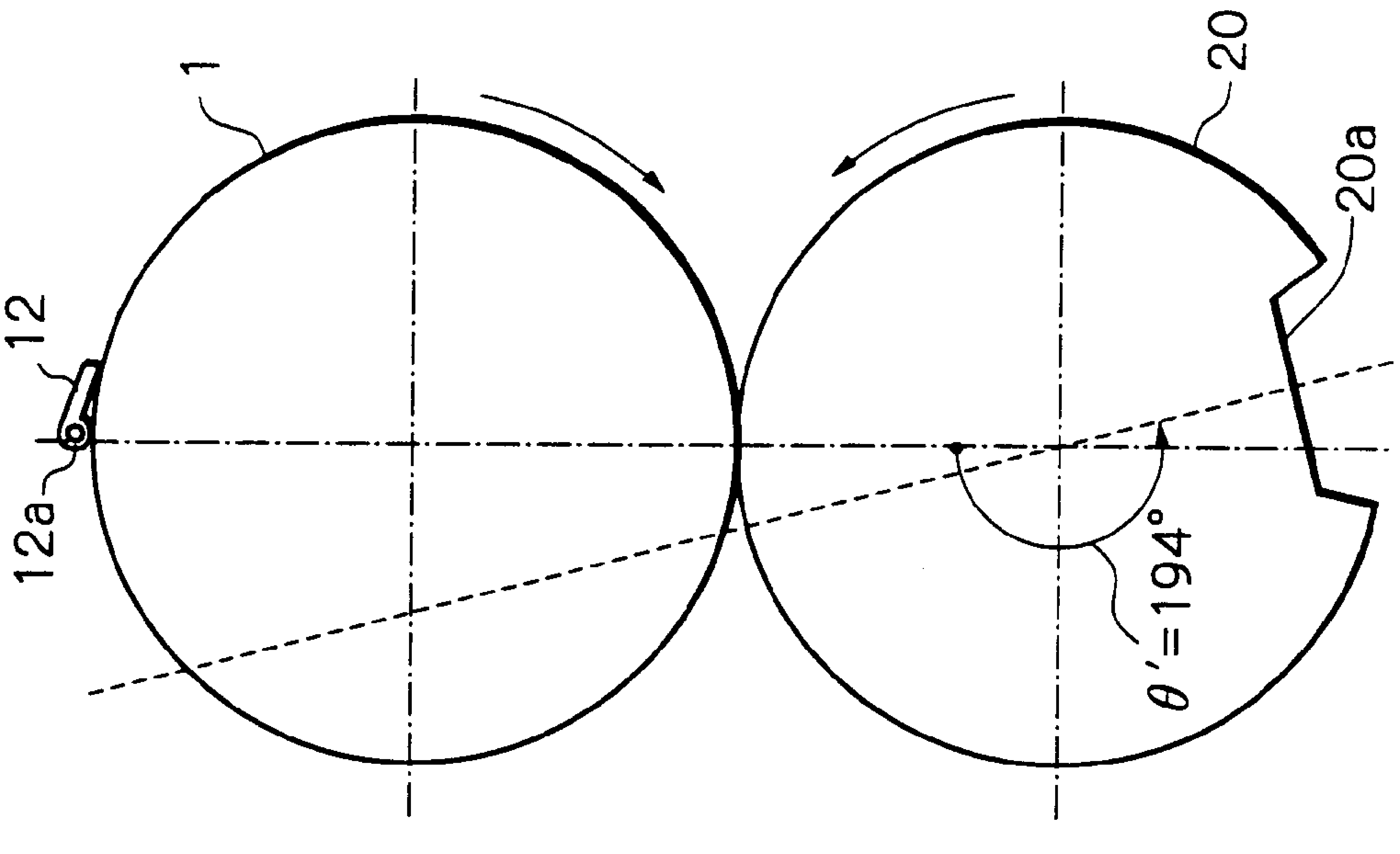


Fig. 13A

INK DRUM POSITION OF 0°

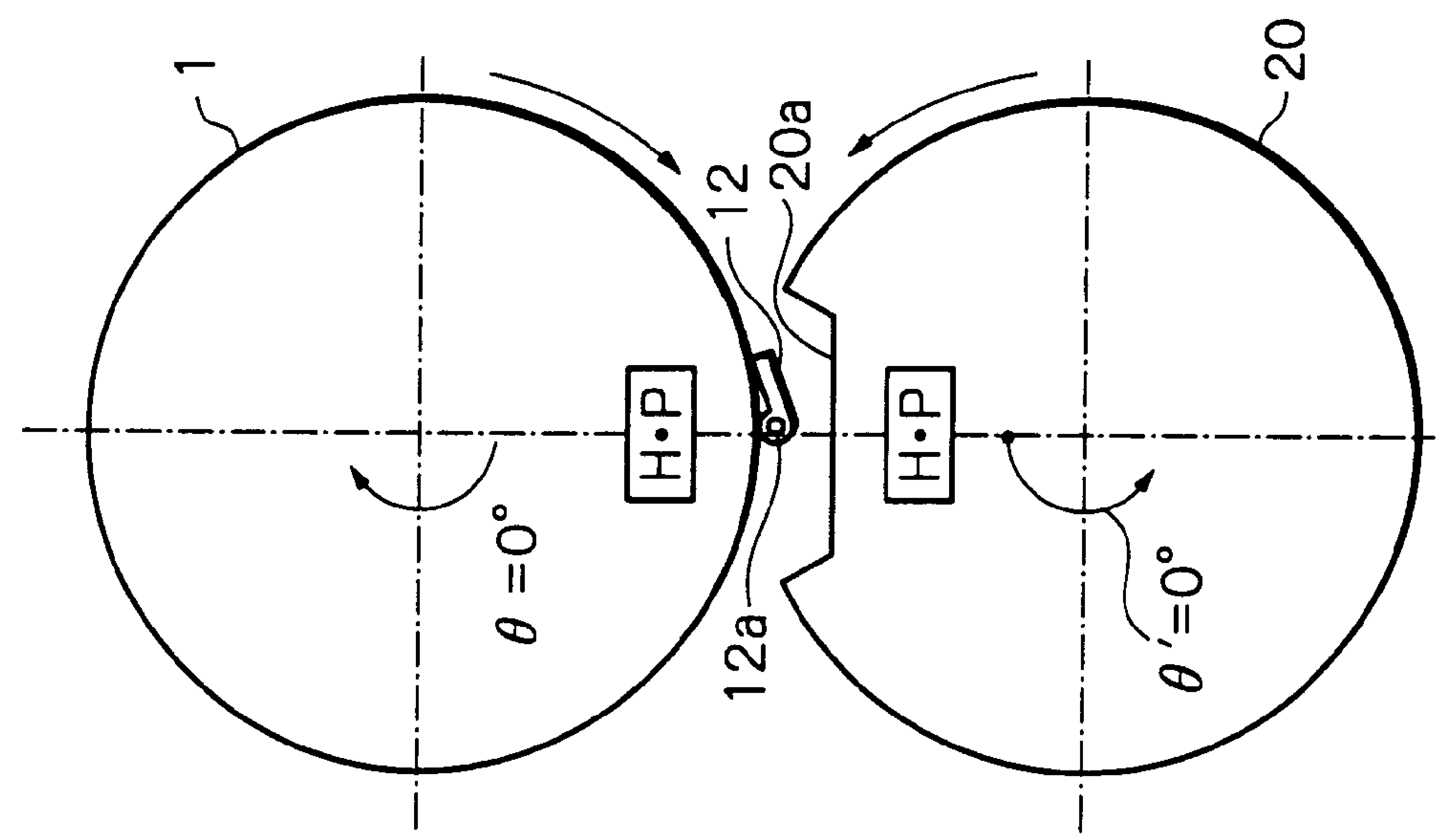
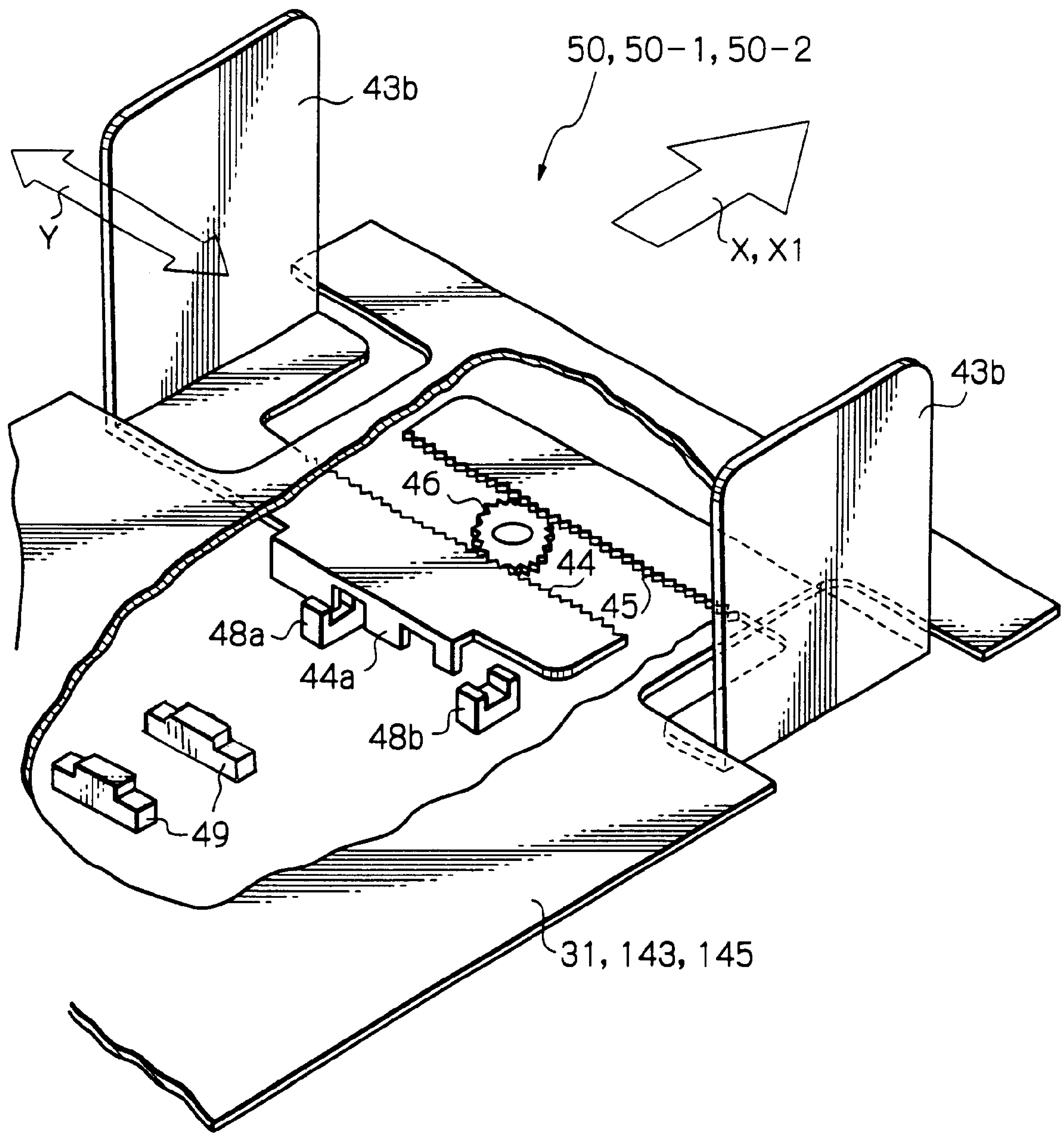


Fig. 14



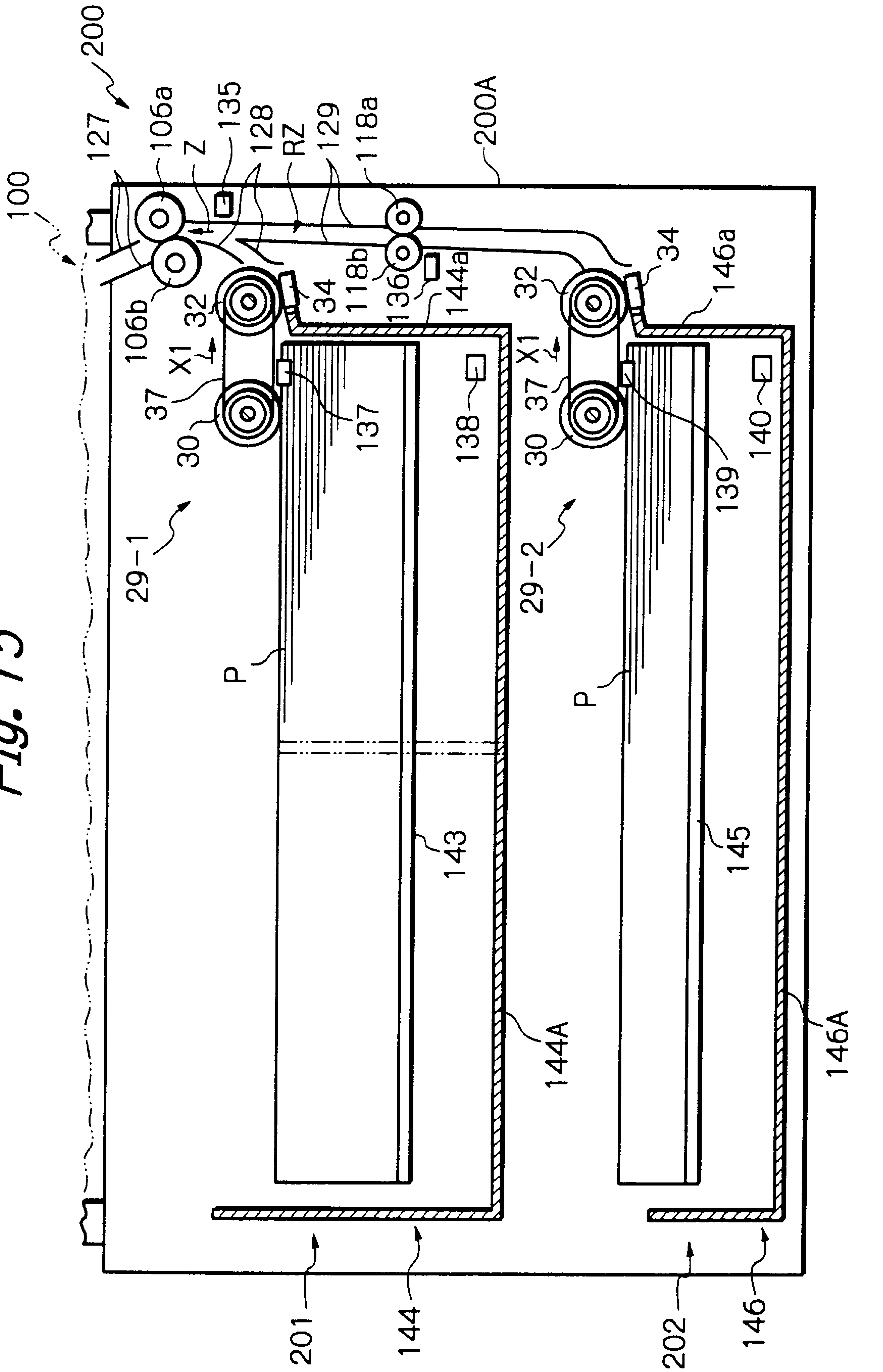
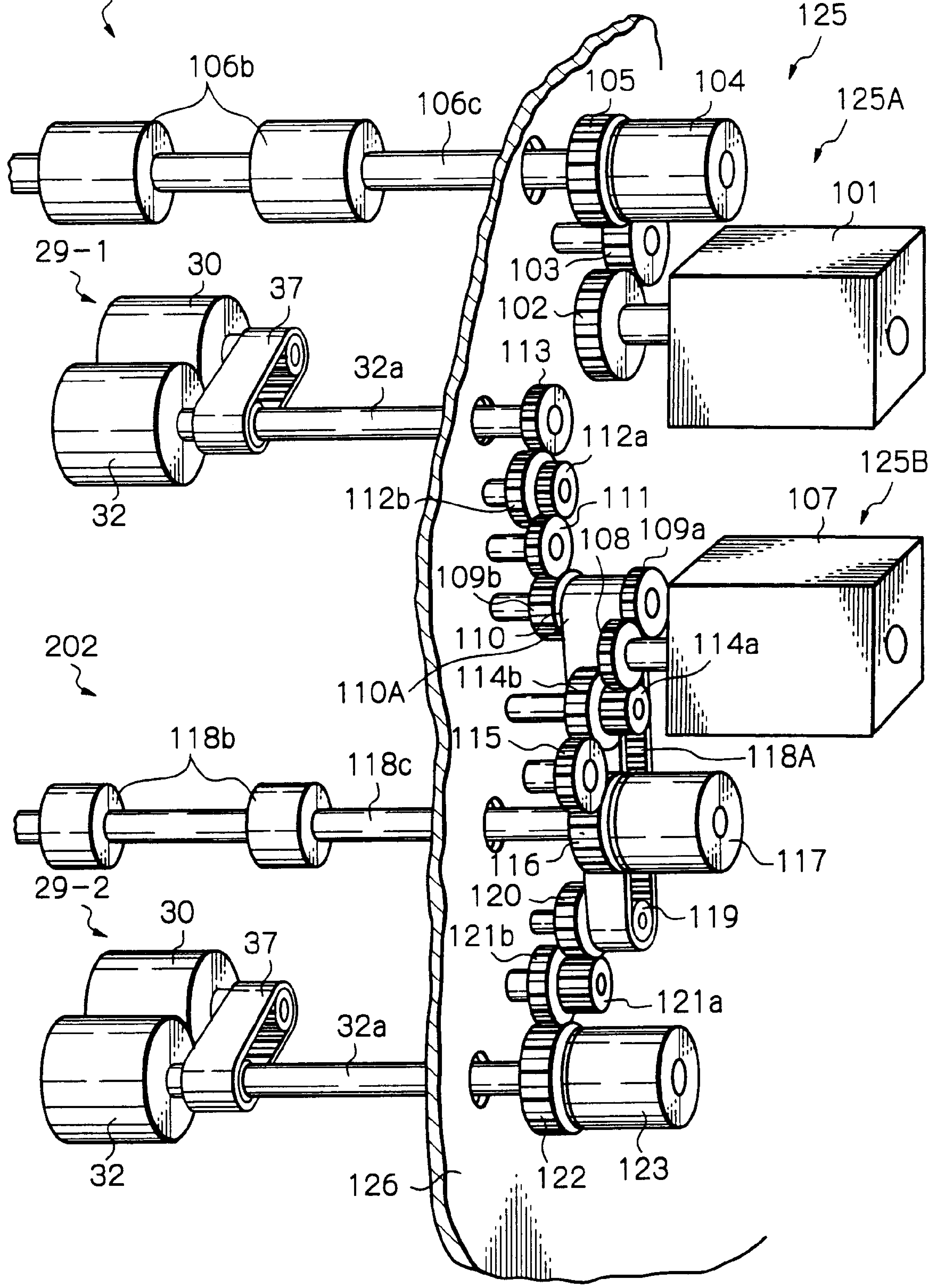

200
200A
100
127
106a
106b
Z
135
128
RZ
129
118a
118b
136
34
32
37
30
X1
137
138
144a
29-1
29-2
139
140
146a
P
143
145
144A
146A
201
144
202
146

Fig. 15

Fig. 16



201
106b
106c
105
104
125
125A
101
29-1
30
37
103
102
113
32a
112a
125B
32
112b
111
107
108
109a
109b
110
114a
202
110A
114b
118A
118b
118c
115
117
116
29-2
120
119
30
121b
37
121a
32a
32
126
122
123

Fig. 17

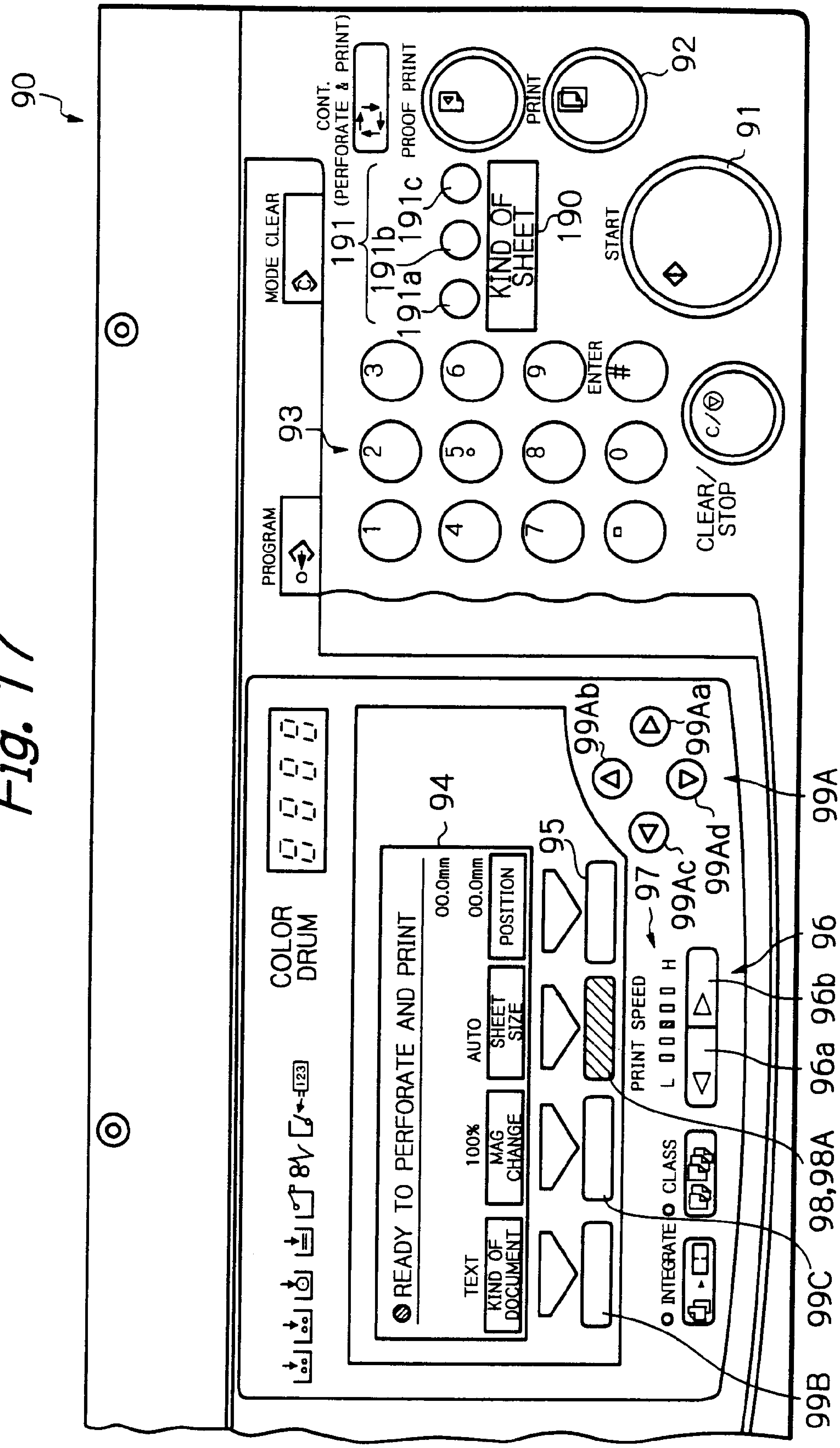
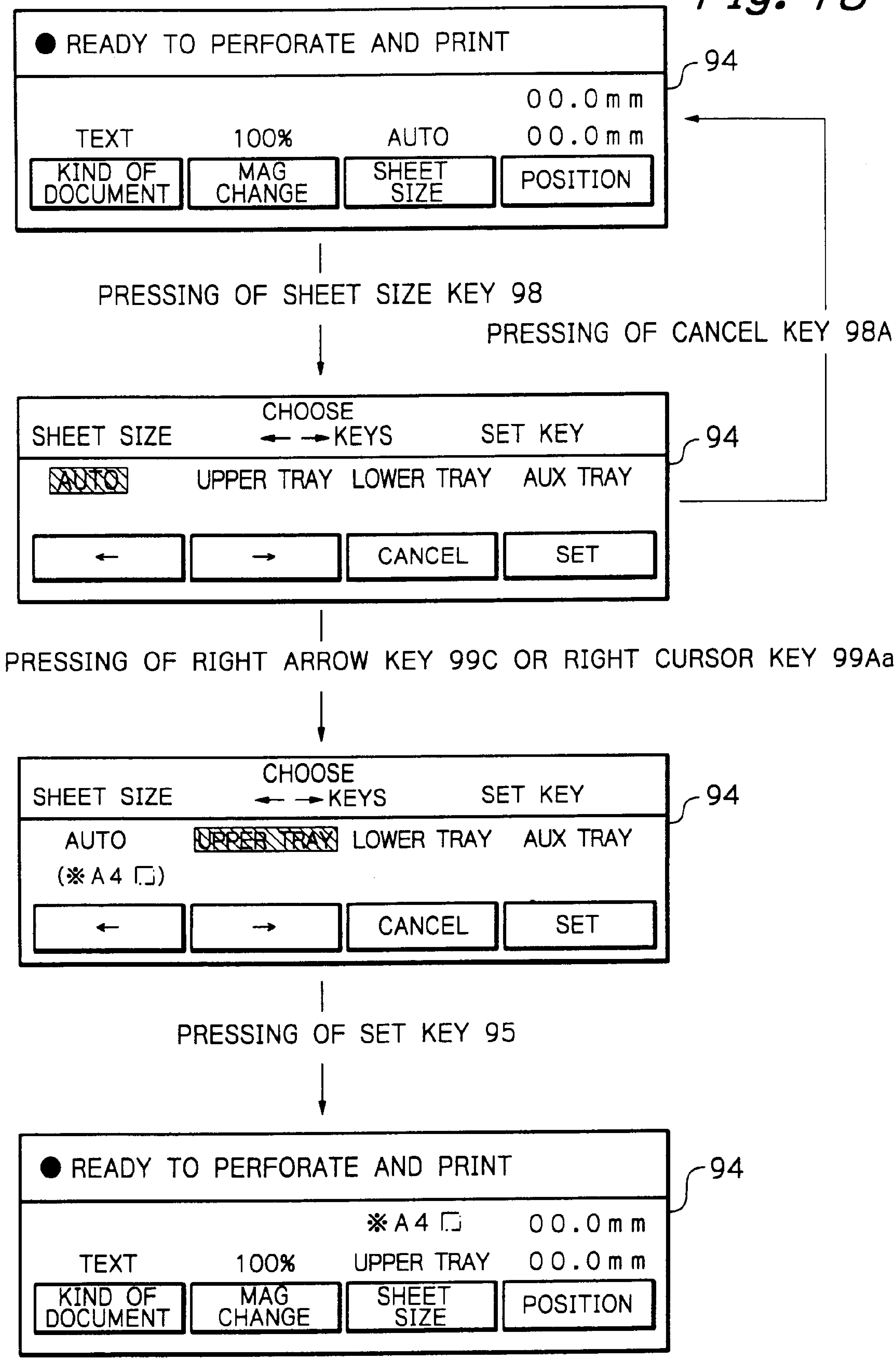

90
MODE CLEAR
PROGRAM
CONT.
PERFORATE & PRINT
191 (PERFORATE & PRINT)
191a
191b
191c
190
KIND OF SHEET
PROOF PRINT
PRINT
92
91
START
93
ENTER
CLEAR/STOP
COLOR
DRUM
94
READY TO PERFORATE AND PRINT
00.0mm
00.0mm
TEXT
KIND OF DOCUMENT
100%
MAG CHANGE
AUTO
SHEET SIZE
POSITION
95
96
96a
96b
97
PRINT SPEED
L H
INTEGRATE
CLASS
98,98A
99A
99Aa
99Ab
99Ac
99Ad
99B
99C

Fig. 18



● READY TO PERFORATE AND PRINT
00.0mm
TEXT
100%
AUTO
00.0mm
KIND OF DOCUMENT
MAG CHANGE
SHEET SIZE
POSITION
94
PRESSING OF SHEET SIZE KEY 98
PRESSING OF CANCEL KEY 98A
SHEET SIZE
CHOOSE ← → KEYS
SET KEY
AUTO
UPPER TRAY
LOWER TRAY
AUX TRAY
←
→
CANCEL
SET
94
PRESSING OF RIGHT ARROW KEY 99C OR RIGHT CURSOR KEY 99Aa
SHEET SIZE
CHOOSE ← → KEYS
SET KEY
AUTO
(※A4)
UPPER TRAY
LOWER TRAY
AUX TRAY
←
→
CANCEL
SET
94
PRESSING OF SET KEY 95
● READY TO PERFORATE AND PRINT
※A4
00.0mm
TEXT
100%
UPPER TRAY
00.0mm
KIND OF DOCUMENT
MAG CHANGE
SHEET SIZE
POSITION
94

Fig. 19

Fig. 19A
Fig. 19B

Fig. 19A

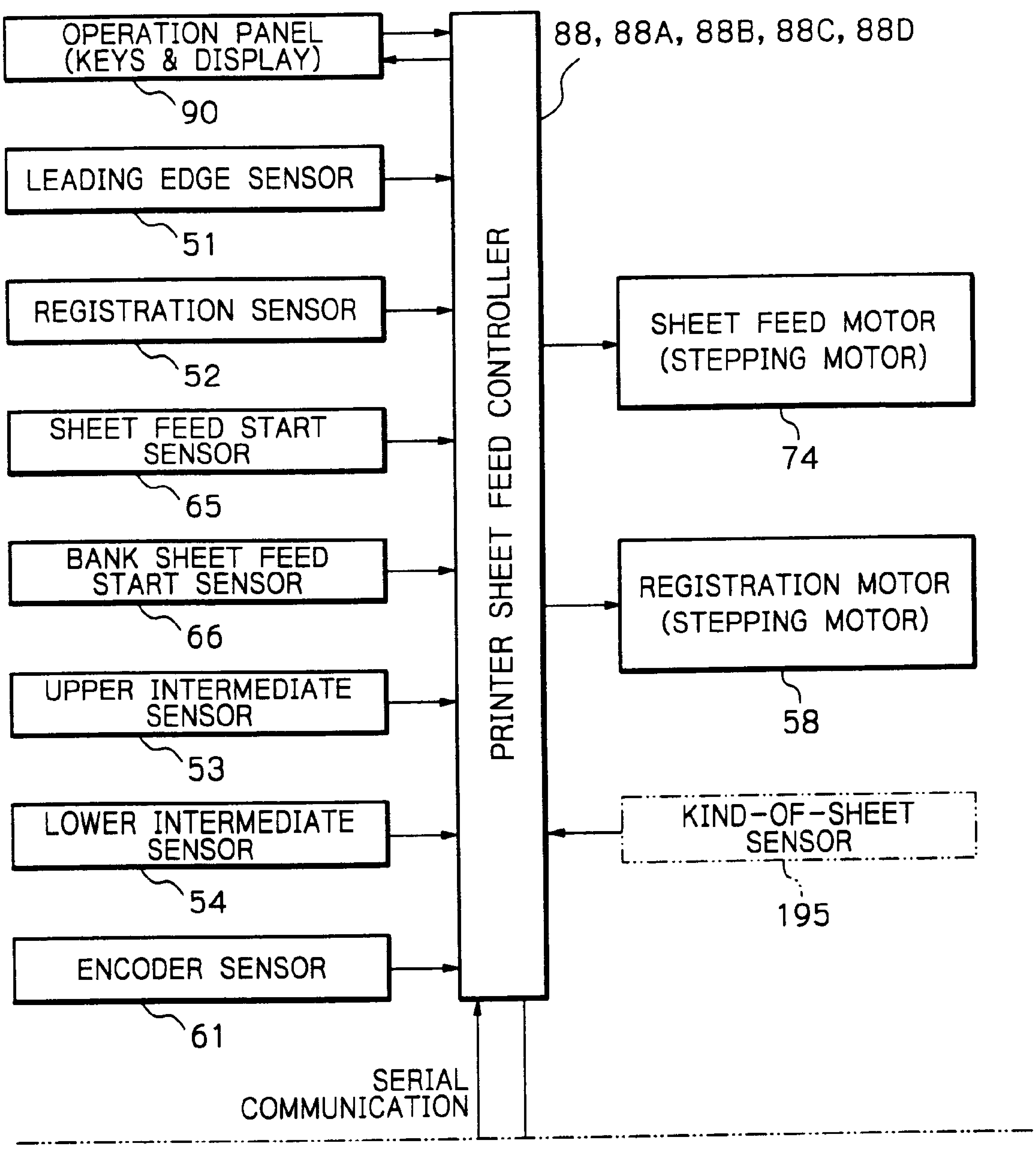


Fig. 19B

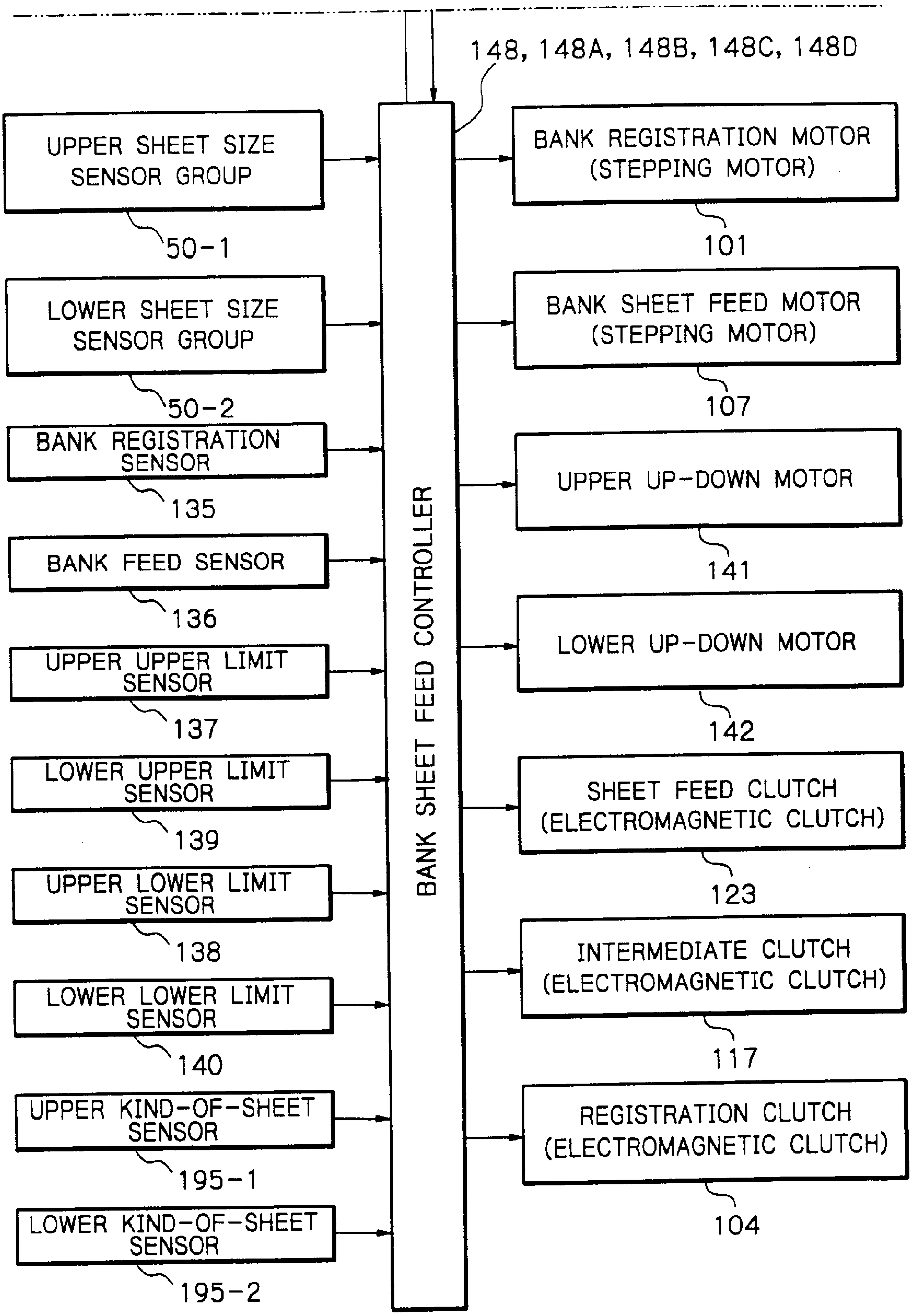

148, 148A, 148B, 148C, 148D
BANK SHEET FEED CONTROLLER
UPPER SHEET SIZE SENSOR GROUP
50-1
LOWER SHEET SIZE SENSOR GROUP
50-2
BANK REGISTRATION SENSOR
135
BANK FEED SENSOR
136
UPPER UPPER LIMIT SENSOR
137
LOWER UPPER LIMIT SENSOR
139
UPPER LOWER LIMIT SENSOR
138
LOWER LOWER LIMIT SENSOR
140
UPPER KIND-OF-SHEET SENSOR
195-1
LOWER KIND-OF-SHEET SENSOR
195-2
BANK REGISTRATION MOTOR (STEPPING MOTOR)
101
BANK SHEET FEED MOTOR (STEPPING MOTOR)
107
UPPER UP-DOWN MOTOR
141
LOWER UP-DOWN MOTOR
142
SHEET FEED CLUTCH (ELECTROMAGNETIC CLUTCH)
123
INTERMEDIATE CLUTCH (ELECTROMAGNETIC CLUTCH)
117
REGISTRATION CLUTCH (ELECTROMAGNETIC CLUTCH)
104

Fig. 20

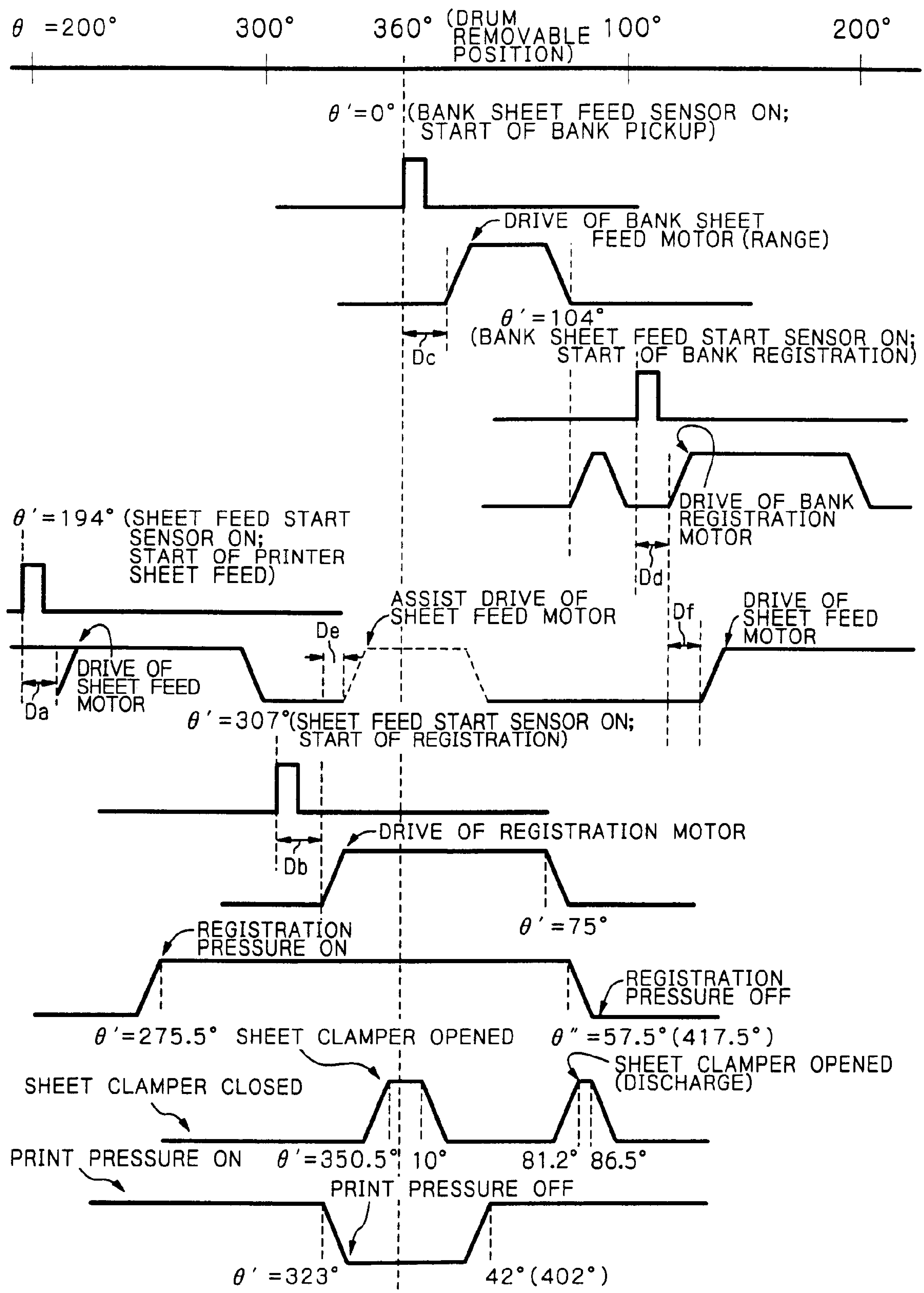

θ =200°
300°
360°
(DRUM REMOVABLE POSITION)
100°
200°
θ'=0° (BANK SHEET FEED SENSOR ON; START OF BANK PICKUP)
DRIVE OF BANK SHEET FEED MOTOR (RANGE)
θ'=104° (BANK SHEET FEED START SENSOR ON; START OF BANK REGISTRATION)
Dc
DRIVE OF BANK REGISTRATION MOTOR
Dd
θ'=194° (SHEET FEED START SENSOR ON; START OF PRINTER SHEET FEED)
De
ASSIST DRIVE OF SHEET FEED MOTOR
Df
DRIVE OF SHEET FEED MOTOR
DRIVE OF SHEET FEED MOTOR
Da
θ'=307°(SHEET FEED START SENSOR ON; START OF REGISTRATION)
DRIVE OF REGISTRATION MOTOR
Db
θ'=75°
REGISTRATION PRESSURE ON
REGISTRATION PRESSURE OFF
θ'=275.5°
SHEET CLAMPER OPENED
θ"=57.5°(417.5°)
SHEET CLAMPER OPENED (DISCHARGE)
SHEET CLAMPER CLOSED
PRINT PRESSURE ON
θ'=350.5°
10°
81.2°
86.5°
PRINT PRESSURE OFF
θ' =323°
42°(402°)

Fig. 21A

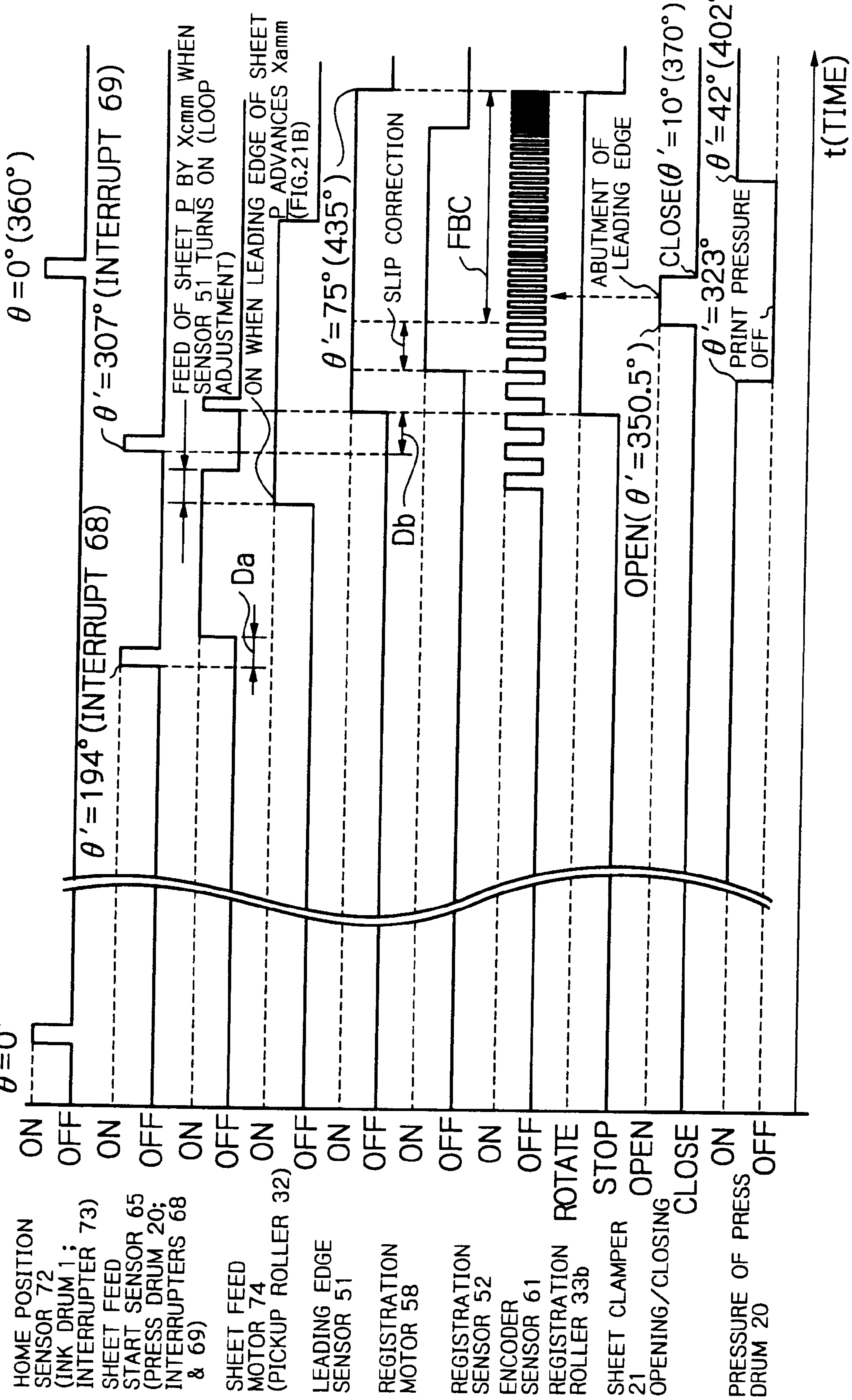

HOME POSITION SENSOR 72 (INK DRUM 1 ; INTERRUPTER 73)
SHEET FEED START SENSOR 65 (PRESS DRUM 20; INTERRUPTERS 68 & 69)
SHEET FEED MOTOR 74 (PICKUP ROLLER 32)
LEADING EDGE SENSOR 51
REGISTRATION MOTOR 58
REGISTRATION SENSOR 52
ENCODER SENSOR 61
REGISTRATION ROLLER 33b
SHEET CLAMPER 21 OPENING/CLOSING
PRESSURE OF PRESS DRUM 20
ON
OFF
ROTATE
STOP
OPEN
CLOSE
θ=0°
θ=0°(360°)
θ'=194°(INTERRUPT 68)
θ'=307°(INTERRUPT 69)
Da
Db
FEED OF SHEET P BY Xcmm WHEN SENSOR 51 TURNS ON (LOOP ADJUSTMENT)
ON WHEN LEADING EDGE OF SHEET P ADVANCES Xamm (FIG.21B)
θ'=75°(435°)
SLIP CORRECTION
FBC
ABUTMENT OF LEADING EDGE
OPEN(θ'=350.5°)
CLOSE(θ'=10°(370°))
θ'=323°
θ'=42°(402°)
PRINT PRESSURE OFF
t(TIME)

Fig. 21B

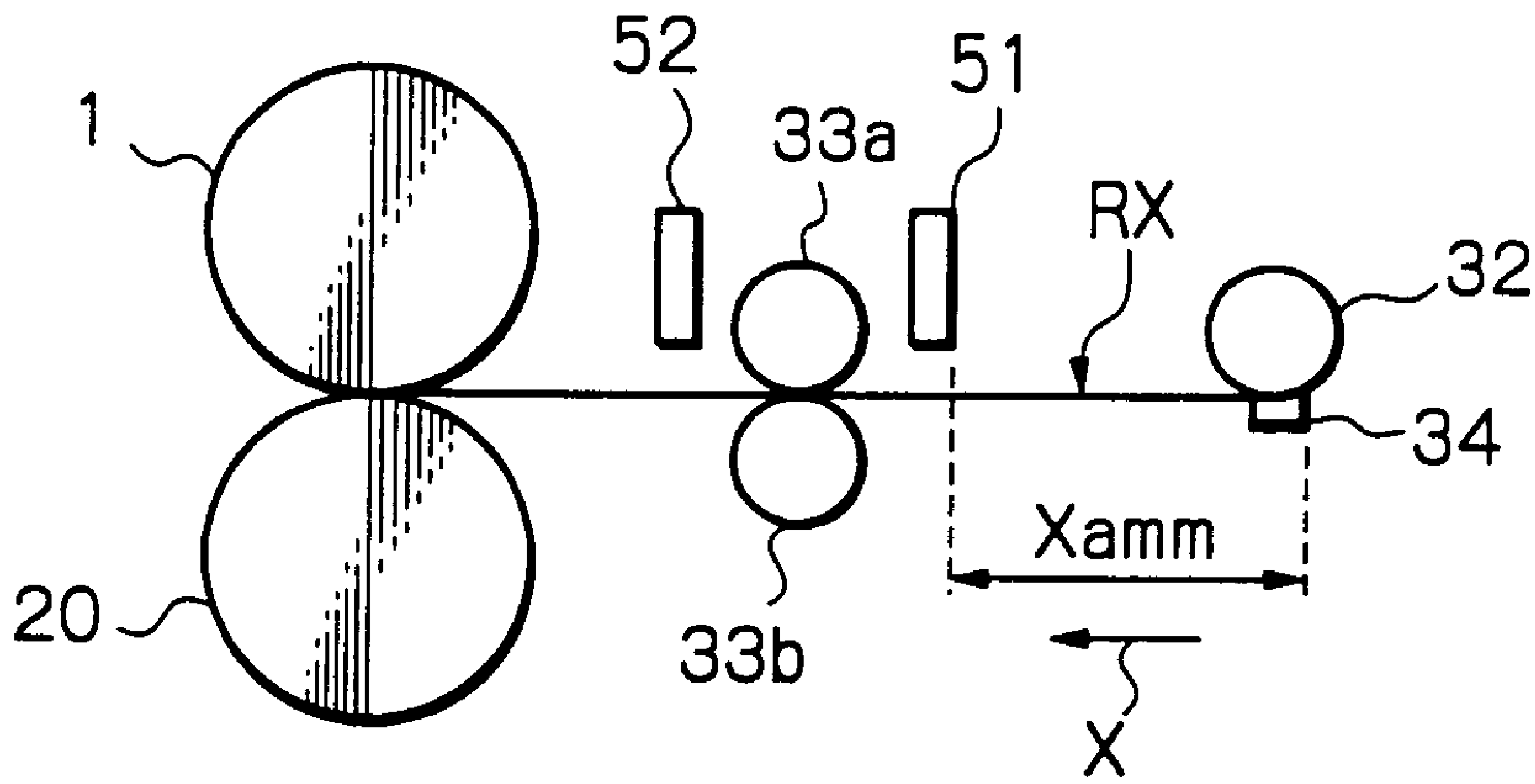


Fig. 21C

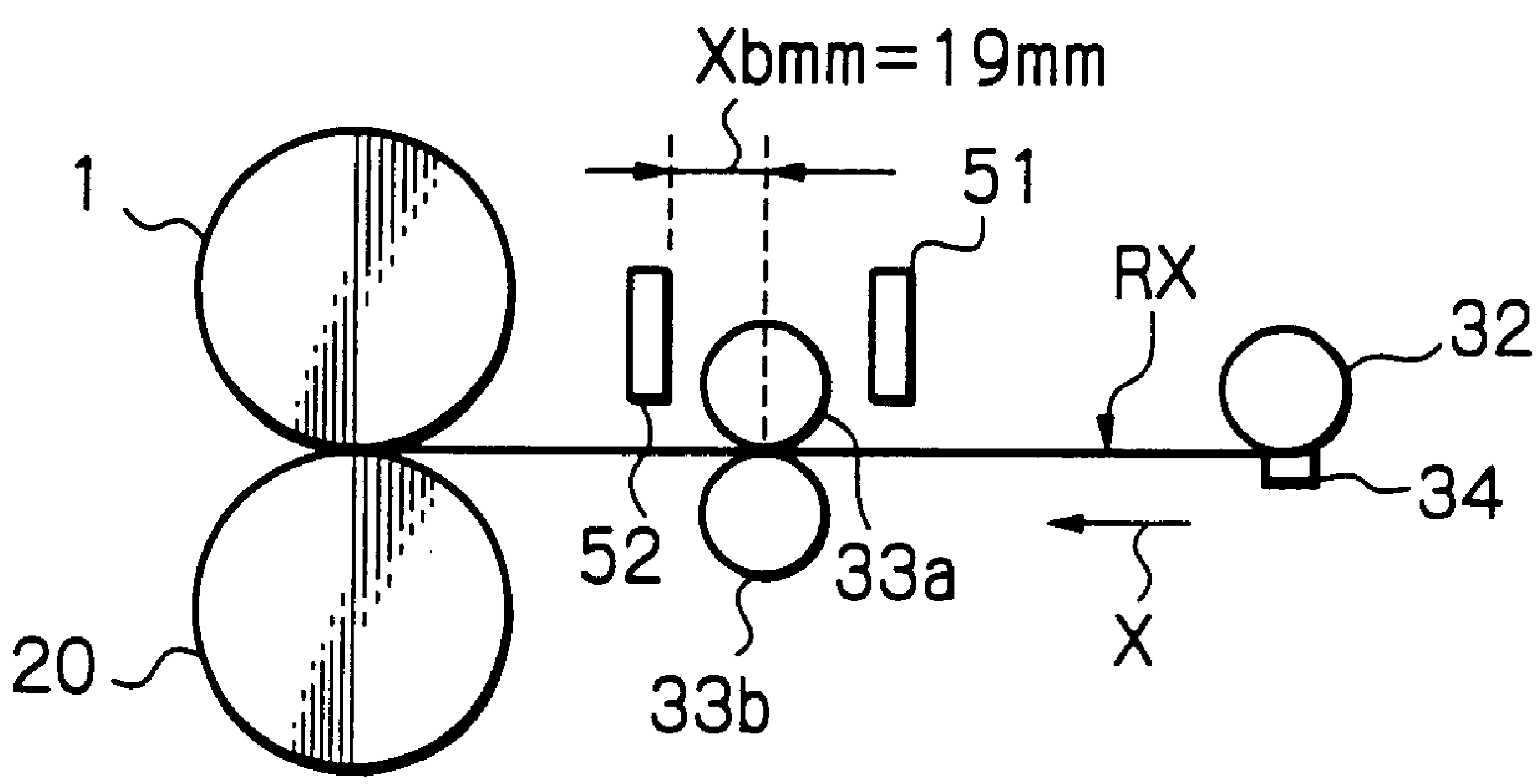


Fig. 22

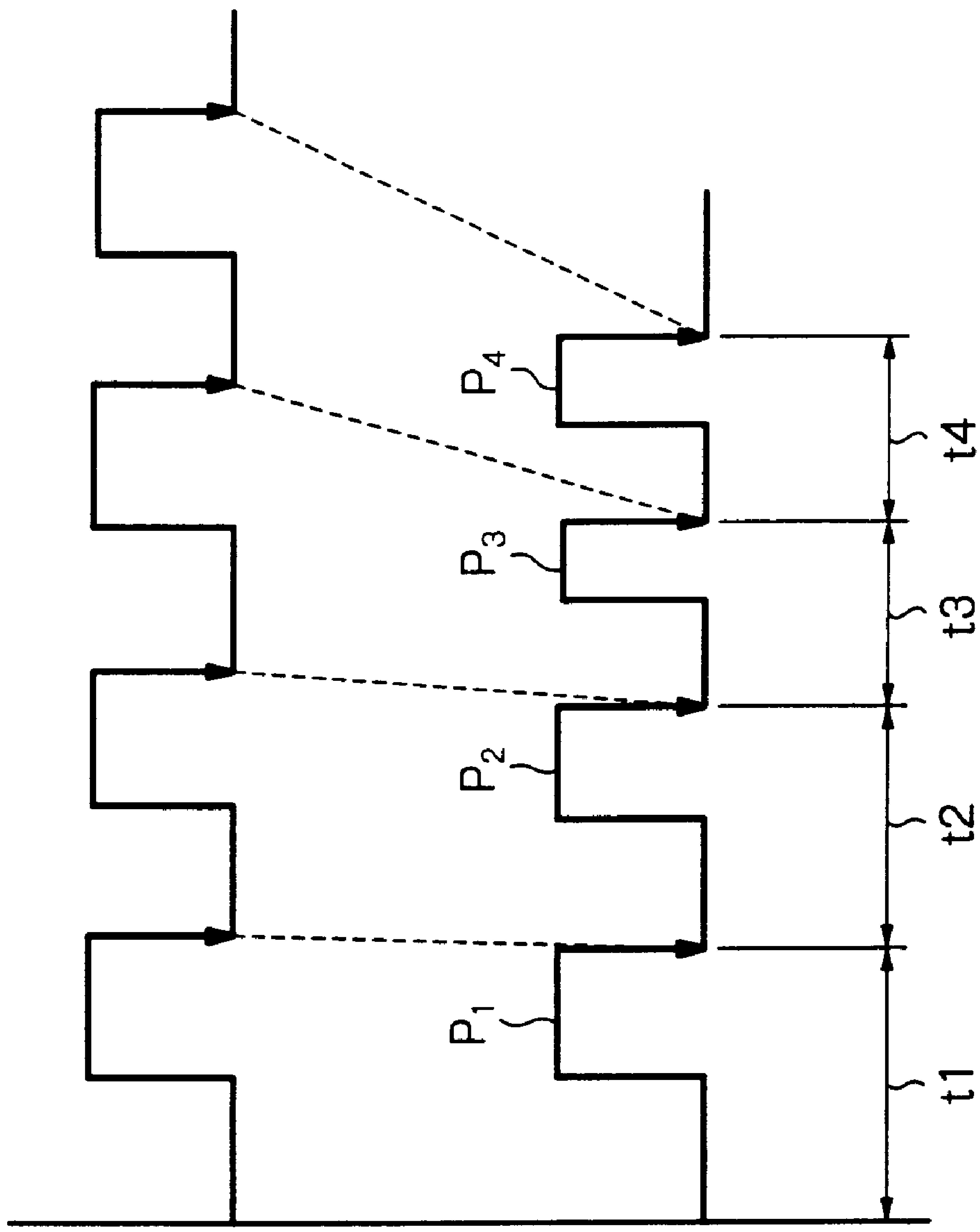


Fig. 23

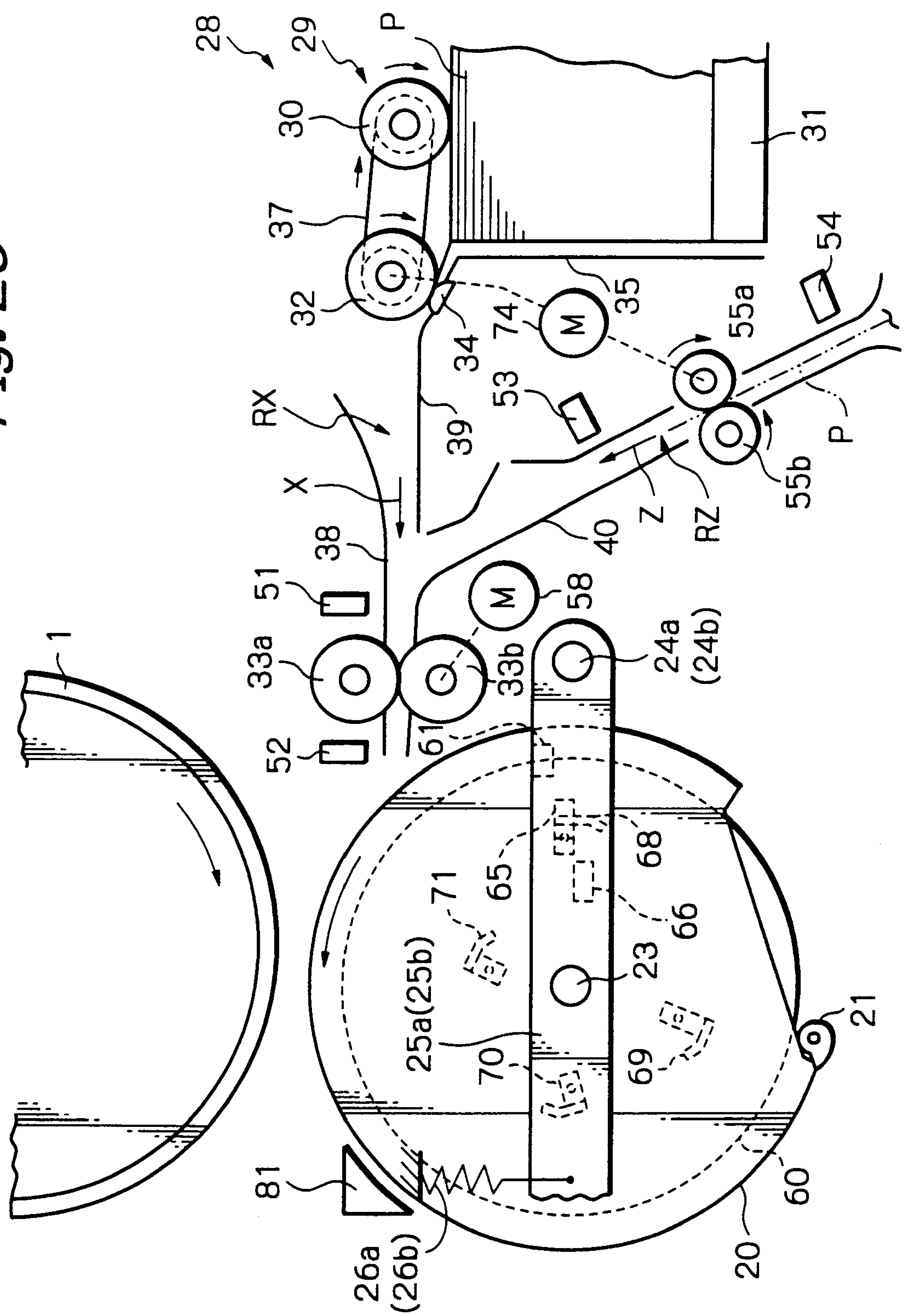

28
29
P
30
37
31
32
34
35
74
M
54
55a
53
39
RX
X
38
51
40
Z
RZ
55b
P
58
M
33a
33b
24a
(24b)
52
61
1
68
65
66
71
23
25a(25b)
70
69
21
81
60
20
26a
(26b)

Fig. 24

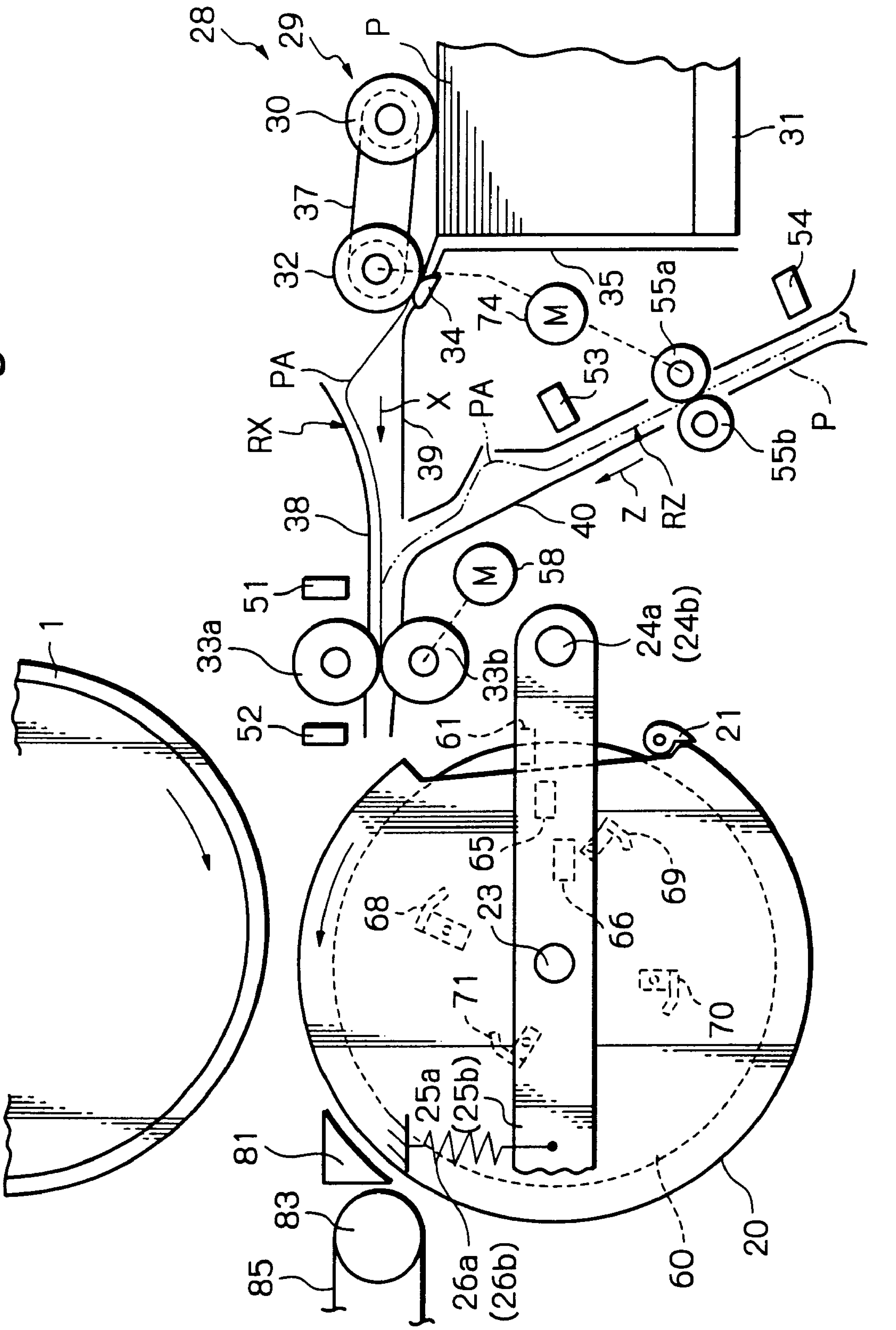

1
20
21
23
24a
(24b)
25a
(25b)
26a
(26b)
28
29
30
31
32
33a
33b
34
35
37
38
39
40
51
52
53
54
55a
55b
58
60
61
65
66
68
69
70
71
74
81
83
85
P
PA
RX
RZ
X
Z
M

Fig. 25

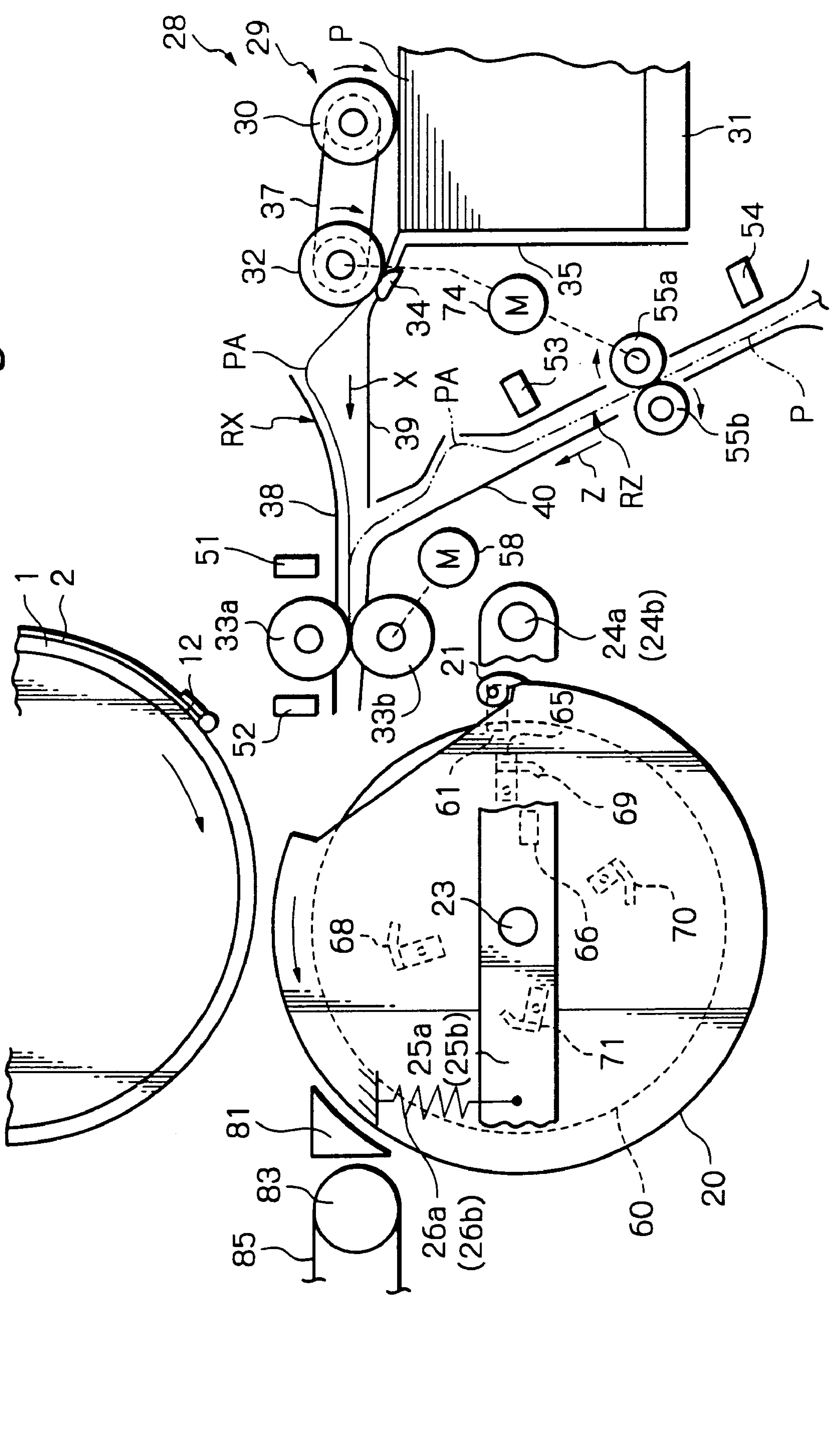

28
29
P
30
31
37
32
35
34
74
M
54
55a
53
PA
RX
X
39
PA
55b
P
38
40
Z
RZ
51
58
1
2
33a
33b
12
52
21
24a
(24b)
65
61
69
23
66
70
68
71
25a
(25b)
81
83
85
26a
(26b)
60
20

Fig. 26

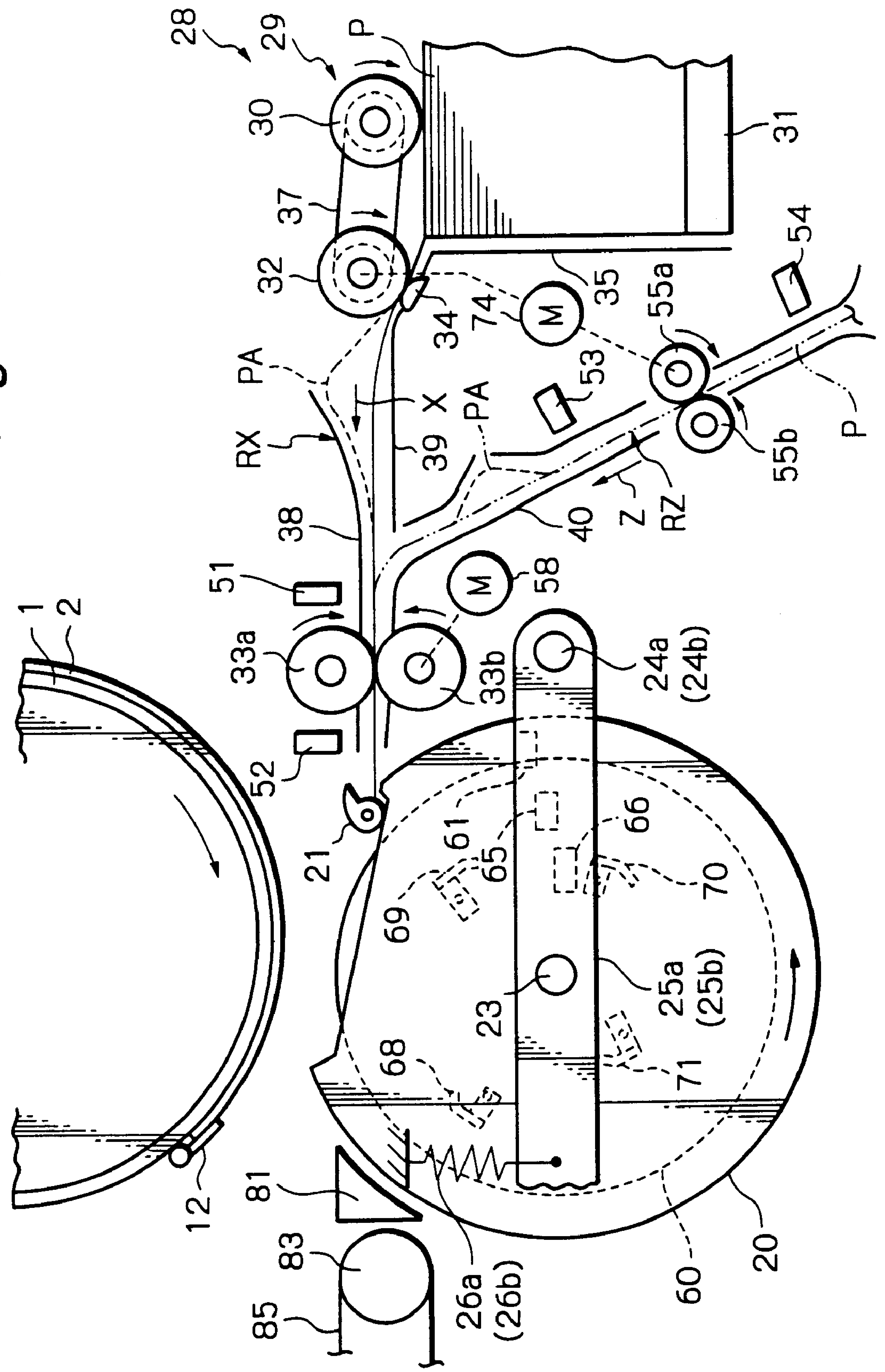

28
29
P
30
31
37
32
35
34
74
M
55a
54
PA
X
PA
53
RX
39
55b
P
38
40
Z
RZ
51
58
M
1
2
33a
33b
24a
(24b)
52
21
61
65
66
69
70
23
25a
(25b)
68
71
12
81
83
85
26a
(26b)
60
20

Fig. 27

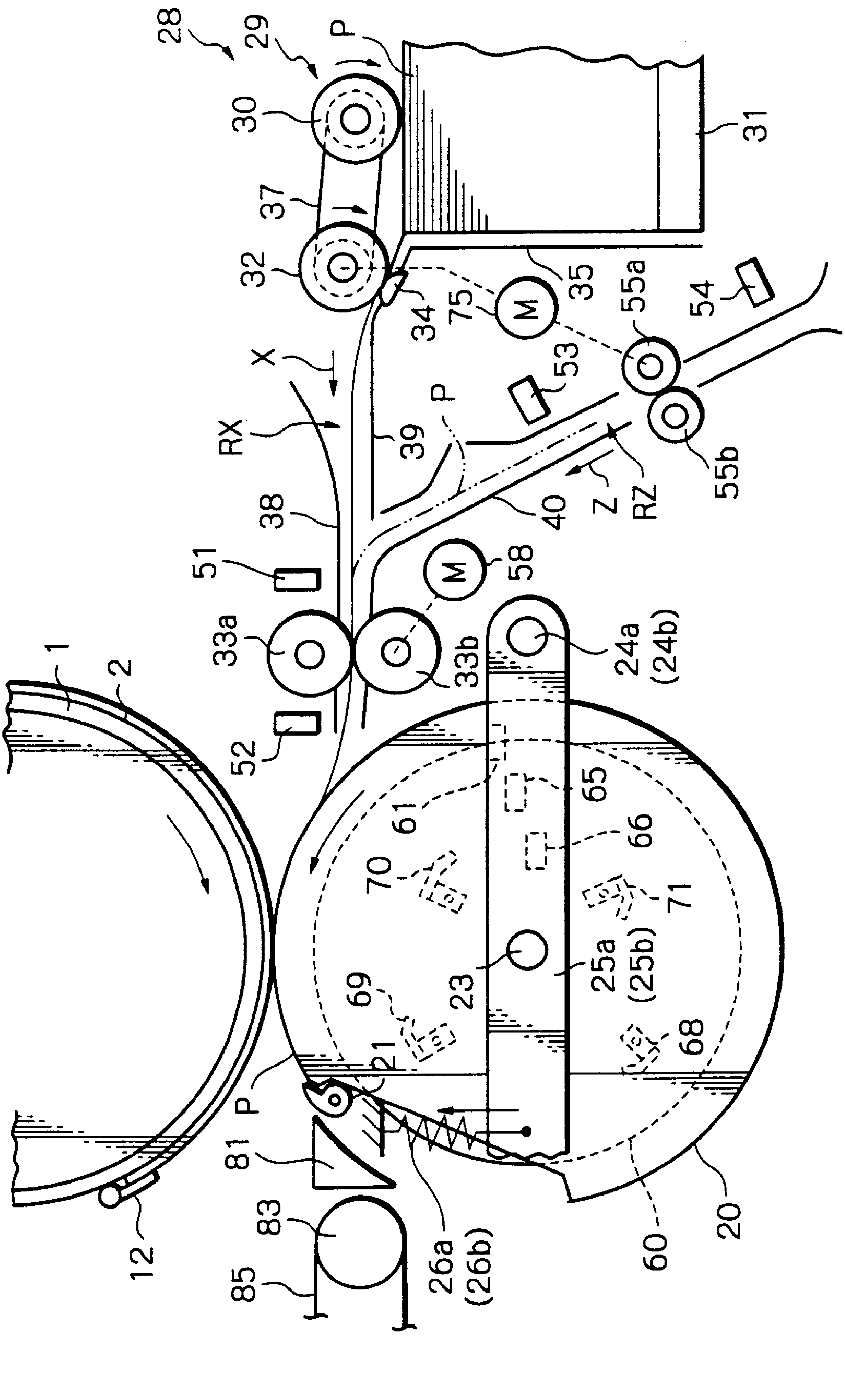

28
29
P
30
31
37
32
35
34
75
M
55a
54
53
X
P
RX
39
55b
38
40
Z
RZ
51
M
58
33a
33b
24a
(24b)
1
2
52
65
61
66
70
71
23
25a
(25b)
69
21
68
P
81
83
20
60
12
85
26a
(26b)

Fig. 28A

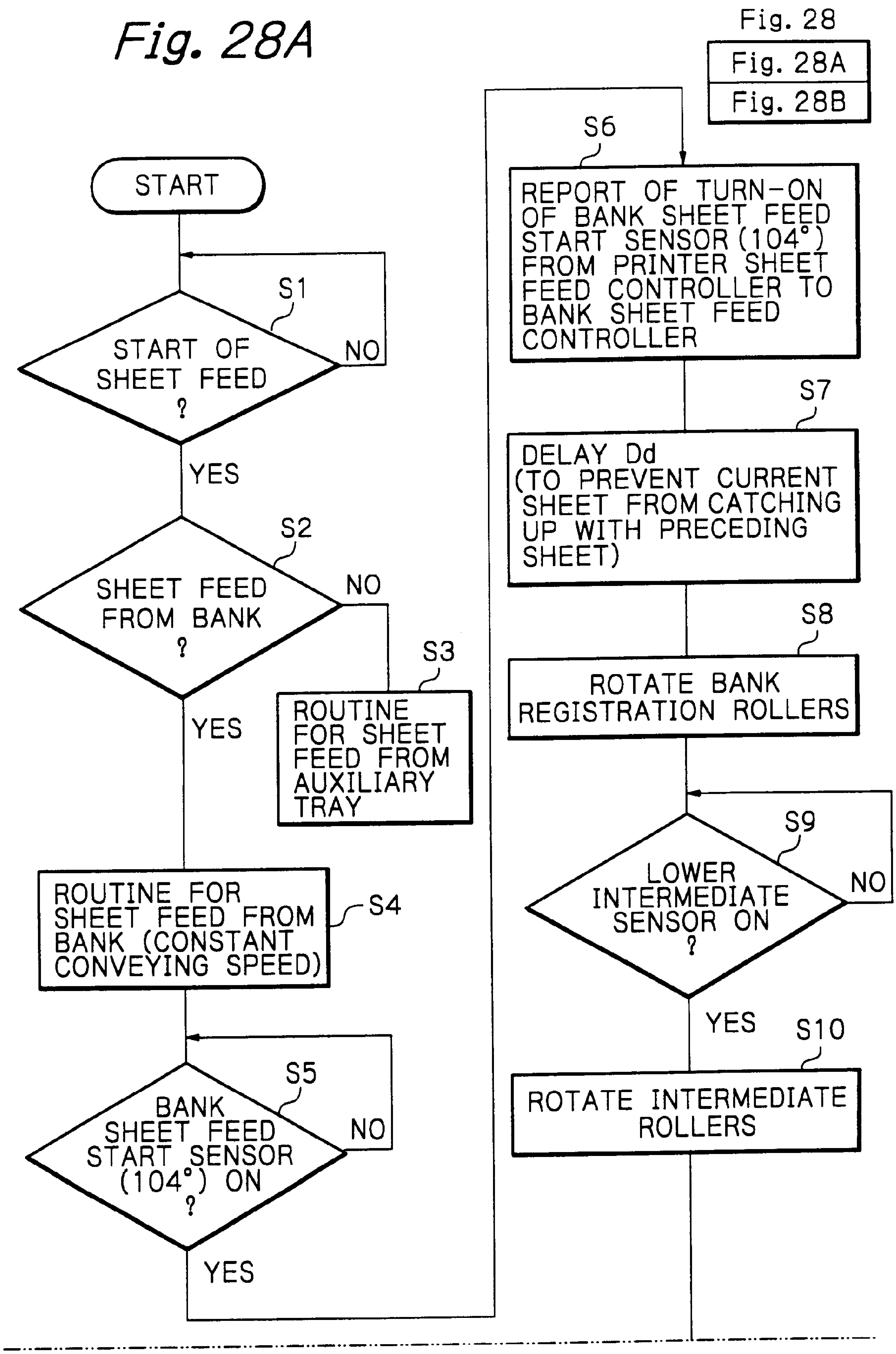


Fig. 28
Fig. 28A
Fig. 28B
START
S1
START OF SHEET FEED ?
NO
YES
S2
SHEET FEED FROM BANK ?
NO
S3
ROUTINE FOR SHEET FEED FROM AUXILIARY TRAY
YES
ROUTINE FOR SHEET FEED FROM BANK (CONSTANT CONVEYING SPEED)
S4
S5
BANK SHEET FEED START SENSOR (104°) ON ?
NO
YES
S6
REPORT OF TURN-ON OF BANK SHEET FEED START SENSOR (104°) FROM PRINTER SHEET FEED CONTROLLER TO BANK SHEET FEED CONTROLLER
S7
DELAY Dd (TO PREVENT CURRENT SHEET FROM CATCHING UP WITH PRECEDING SHEET)
S8
ROTATE BANK REGISTRATION ROLLERS
S9
LOWER INTERMEDIATE SENSOR ON ?
NO
YES
S10
ROTATE INTERMEDIATE ROLLERS

Fig. 28B

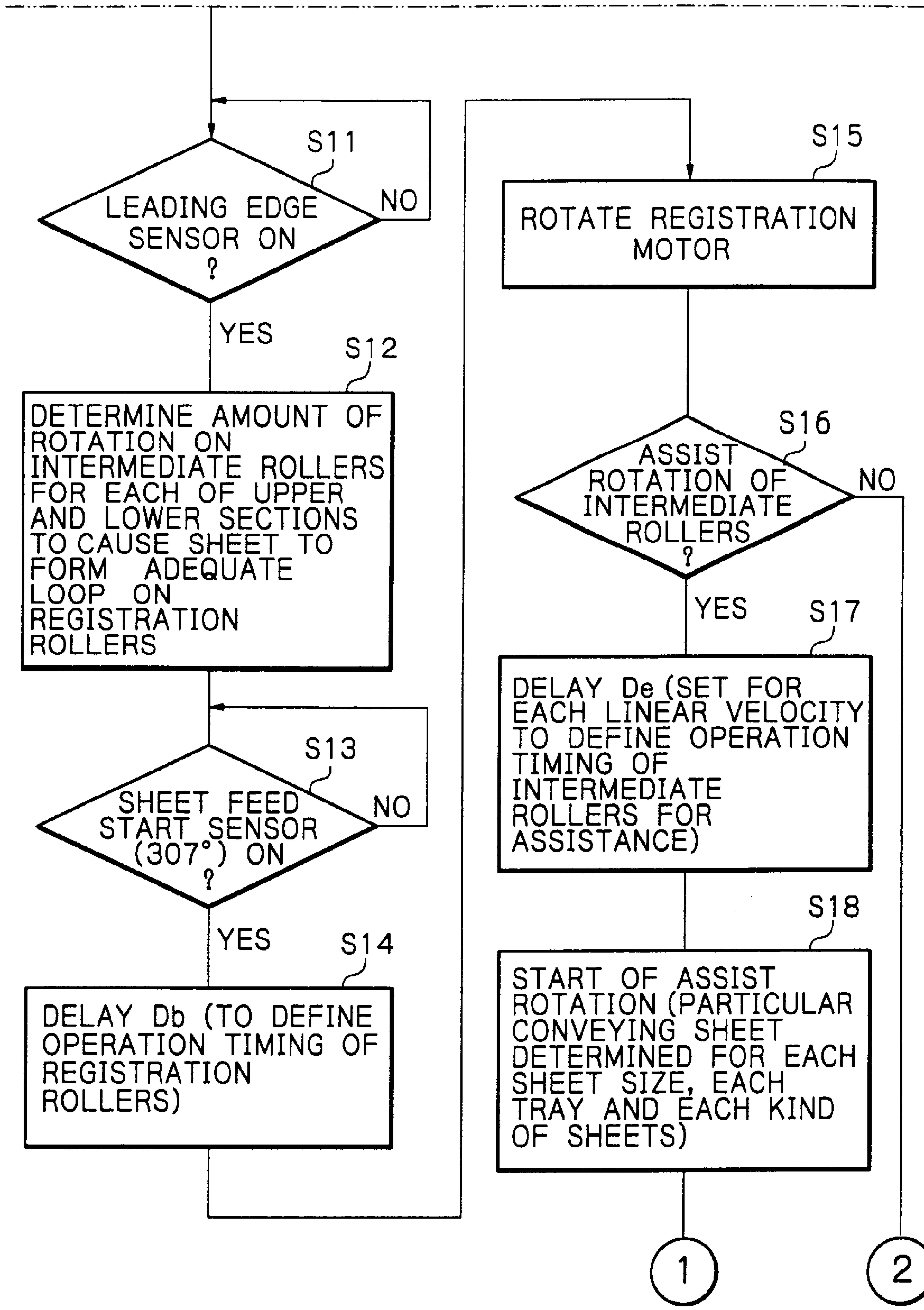

S11
LEADING EDGE SENSOR ON ?
NO
YES
S12
DETERMINE AMOUNT OF ROTATION ON INTERMEDIATE ROLLERS FOR EACH OF UPPER AND LOWER SECTIONS TO CAUSE SHEET TO FORM ADEQUATE LOOP ON REGISTRATION ROLLERS
S13
SHEET FEED START SENSOR (307°) ON ?
NO
YES
S14
DELAY Db (TO DEFINE OPERATION TIMING OF REGISTRATION ROLLERS)
S15
ROTATE REGISTRATION MOTOR
S16
ASSIST ROTATION OF INTERMEDIATE ROLLERS ?
NO
YES
S17
DELAY De (SET FOR EACH LINEAR VELOCITY TO DEFINE OPERATION TIMING OF INTERMEDIATE ROLLERS FOR ASSISTANCE)
S18
START OF ASSIST ROTATION (PARTICULAR CONVEYING SHEET DETERMINED FOR EACH SHEET SIZE, EACH TRAY AND EACH KIND OF SHEETS)
1
2

Fig. 29

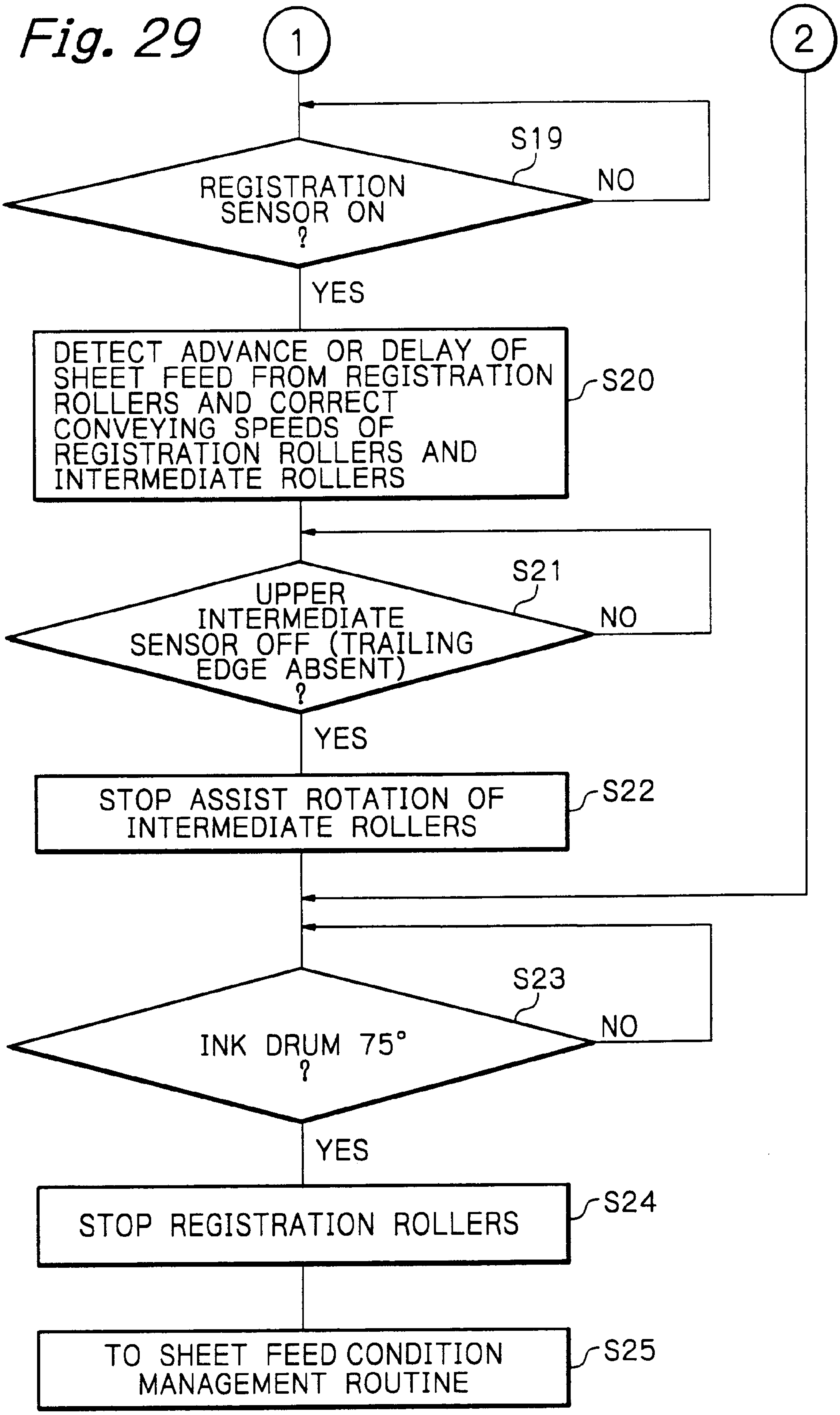

1
2
S19
REGISTRATION SENSOR ON ?
NO
YES
DETECT ADVANCE OR DELAY OF SHEET FEED FROM REGISTRATION ROLLERS AND CORRECT CONVEYING SPEEDS OF REGISTRATION ROLLERS AND INTERMEDIATE ROLLERS
S20
S21
UPPER INTERMEDIATE SENSOR OFF (TRAILING EDGE ABSENT) ?
NO
YES
STOP ASSIST ROTATION OF INTERMEDIATE ROLLERS
S22
S23
INK DRUM 75° ?
NO
YES
STOP REGISTRATION ROLLERS
S24
TO SHEET FEED CONDITION MANAGEMENT ROUTINE
S25

Fig. 30

Fig. 30A
Fig. 30B

Fig. 30A

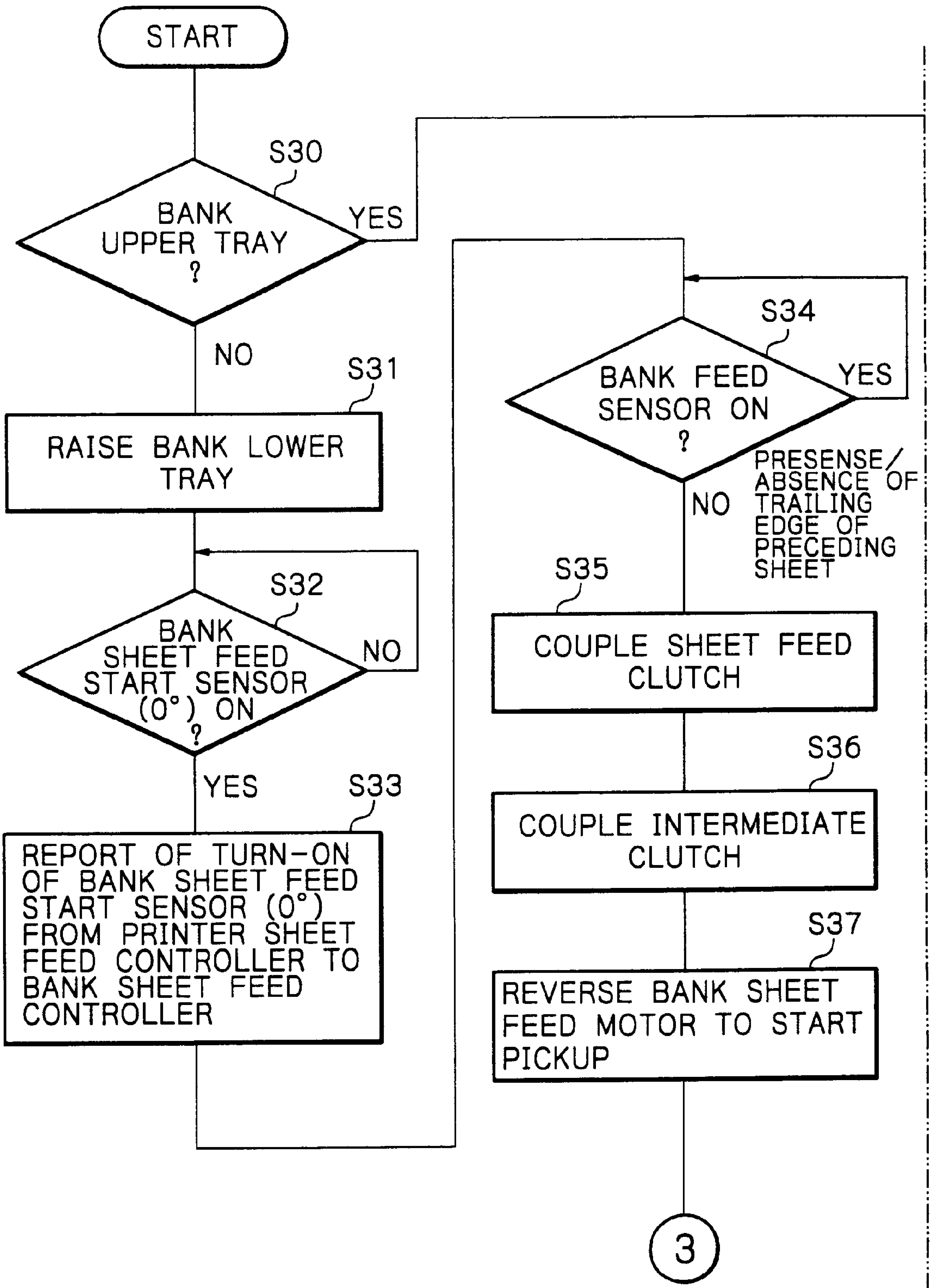


Fig. 30B

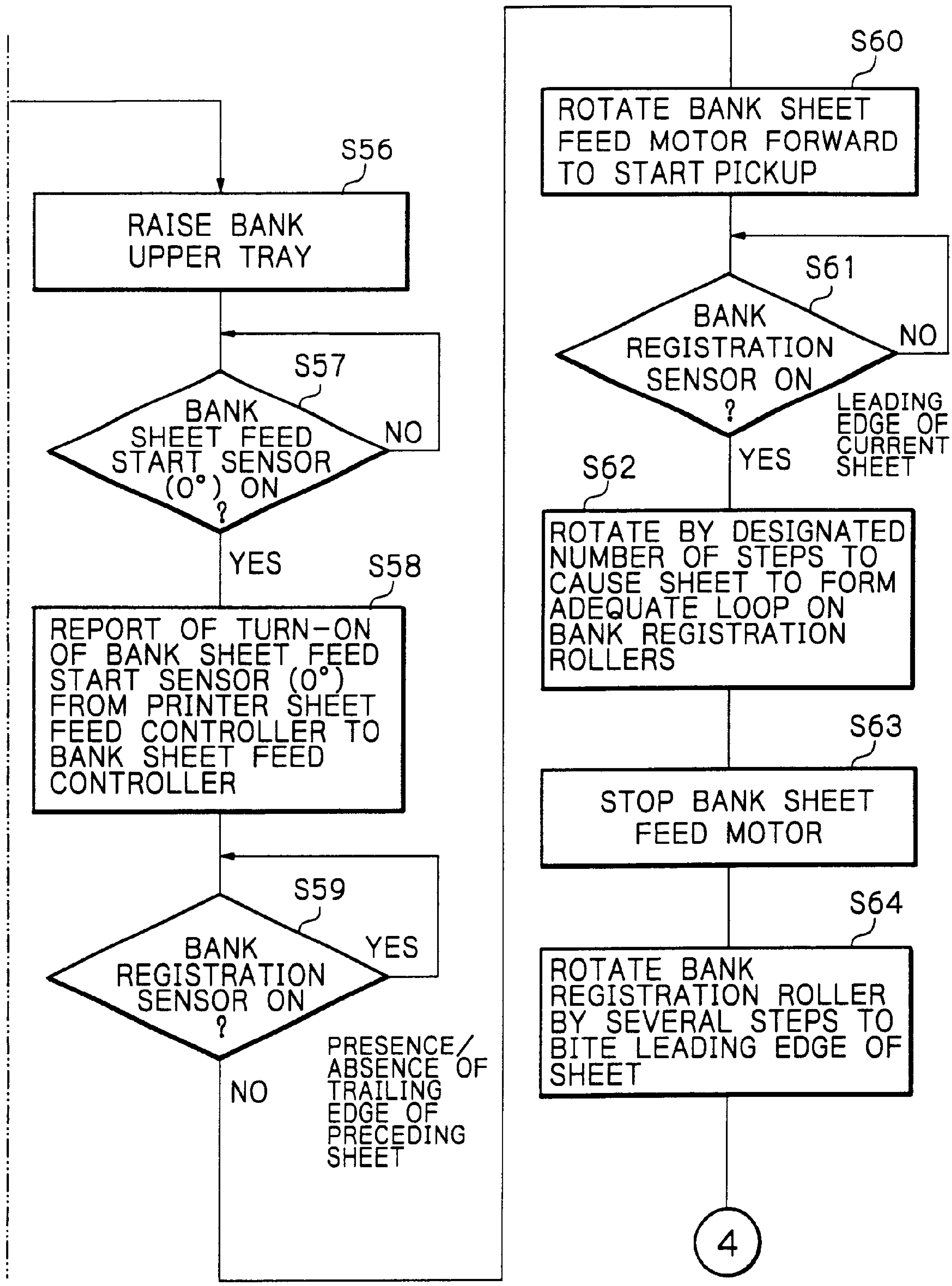

S56
RAISE BANK UPPER TRAY
S57
BANK SHEET FEED START SENSOR (0°) ON ?
NO
YES
S58
REPORT OF TURN-ON OF BANK SHEET FEED START SENSOR (0°) FROM PRINTER SHEET FEED CONTROLLER TO BANK SHEET FEED CONTROLLER
S59
BANK REGISTRATION SENSOR ON ?
YES
NO
PRESENCE/ ABSENCE OF TRAILING EDGE OF PRECEDING SHEET
S60
ROTATE BANK SHEET FEED MOTOR FORWARD TO START PICKUP
S61
BANK REGISTRATION SENSOR ON ?
NO
YES
LEADING EDGE OF CURRENT SHEET
S62
ROTATE BY DESIGNATED NUMBER OF STEPS TO CAUSE SHEET TO FORM ADEQUATE LOOP ON BANK REGISTRATION ROLLERS
S63
STOP BANK SHEET FEED MOTOR
S64
ROTATE BANK REGISTRATION ROLLER BY SEVERAL STEPS TO BITE LEADING EDGE OF SHEET
4

Fig. 31A

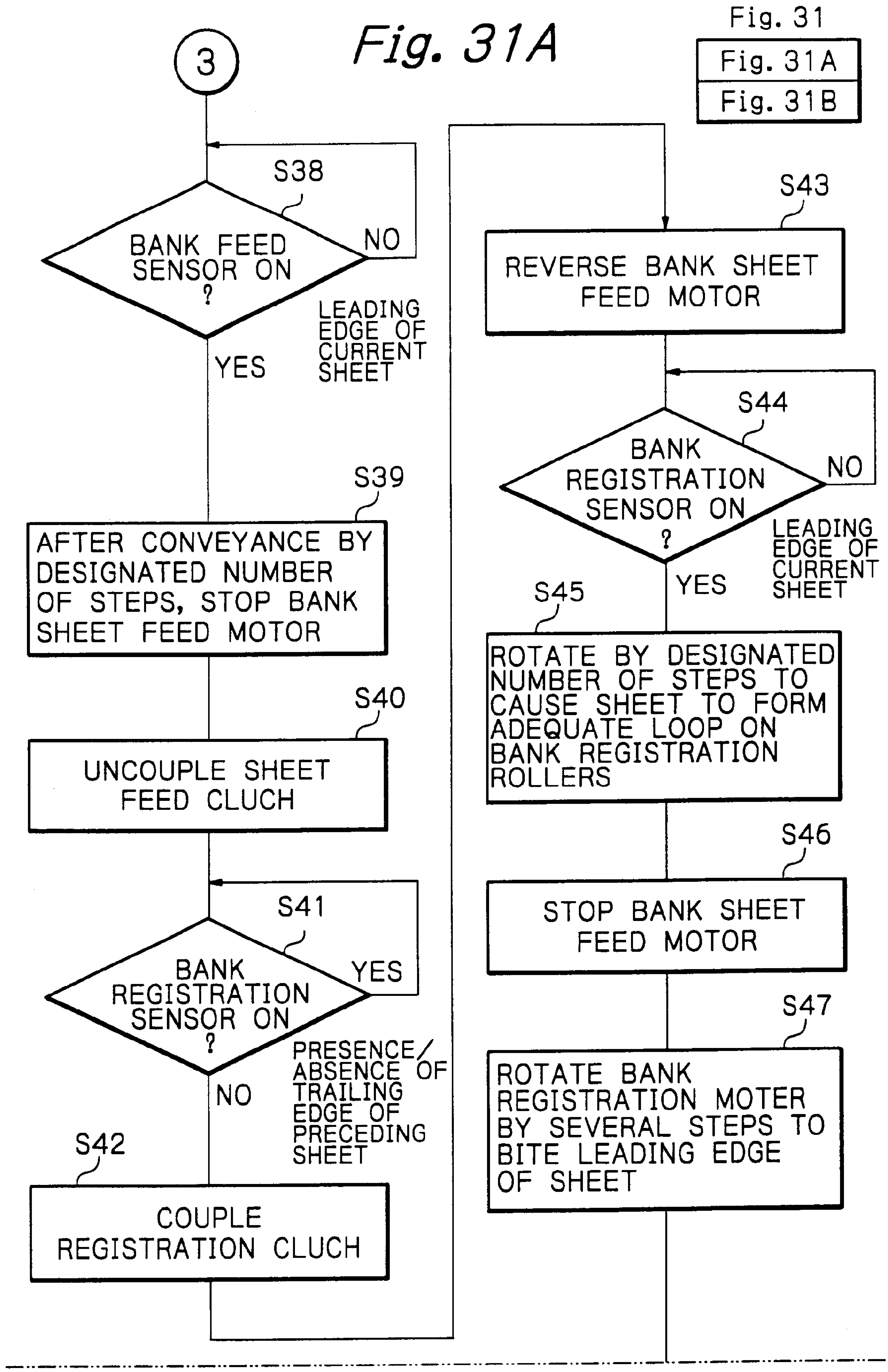


Fig. 31
Fig. 31A
Fig. 31B
3
S38
BANK FEED SENSOR ON ?
NO
YES
LEADING EDGE OF CURRENT SHEET
S39
AFTER CONVEYANCE BY DESIGNATED NUMBER OF STEPS, STOP BANK SHEET FEED MOTOR
S40
UNCOUPLE SHEET FEED CLUCH
S41
BANK REGISTRATION SENSOR ON ?
YES
NO
PRESENCE/ ABSENCE OF TRAILING EDGE OF PRECEDING SHEET
S42
COUPLE REGISTRATION CLUCH
S43
REVERSE BANK SHEET FEED MOTOR
S44
BANK REGISTRATION SENSOR ON ?
NO
YES
LEADING EDGE OF CURRENT SHEET
S45
ROTATE BY DESIGNATED NUMBER OF STEPS TO CAUSE SHEET TO FORM ADEQUATE LOOP ON BANK REGISTRATION ROLLERS
S46
STOP BANK SHEET FEED MOTOR
S47
ROTATE BANK REGISTRATION MOTER BY SEVERAL STEPS TO BITE LEADING EDGE OF SHEET

Fig. 31B

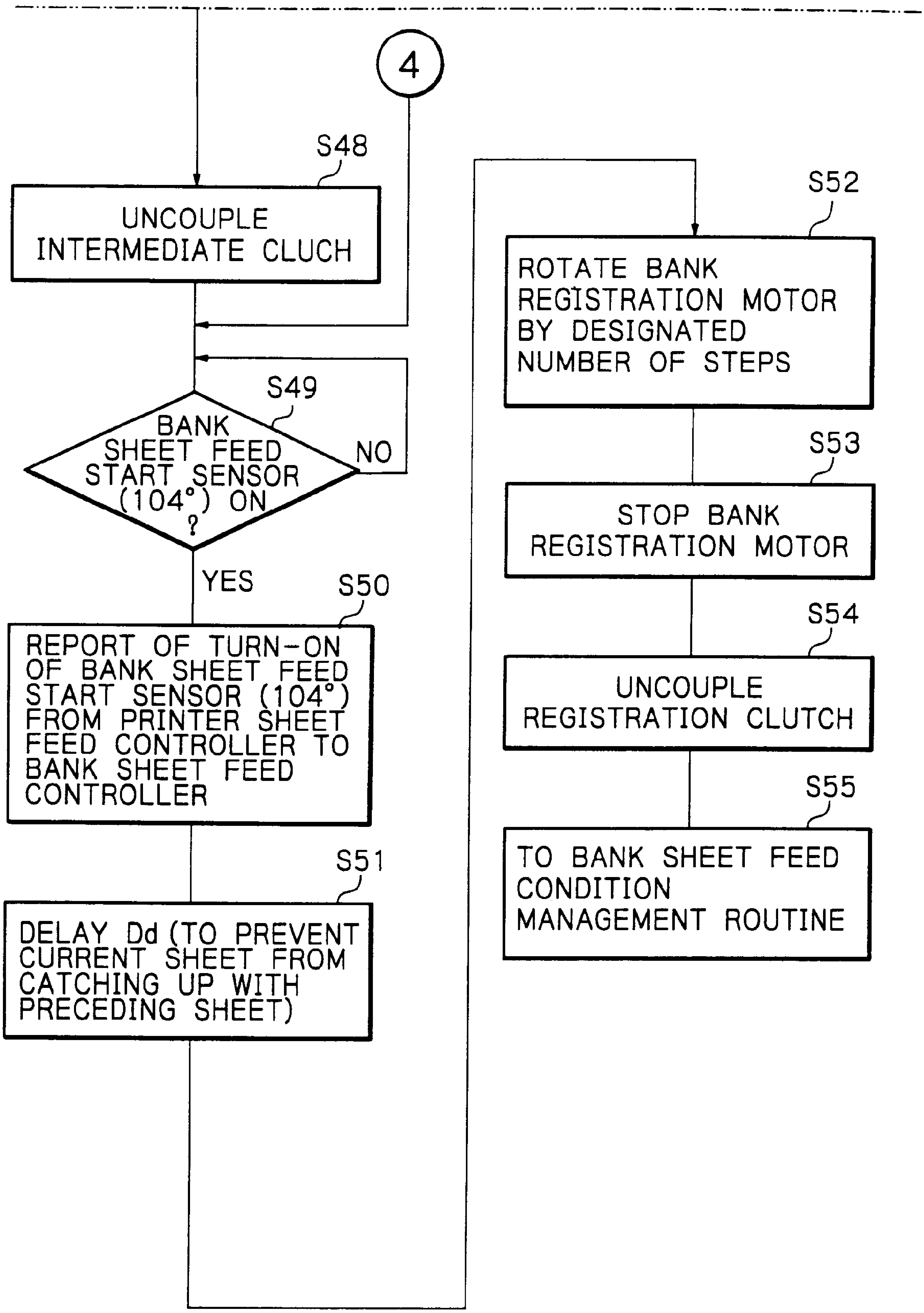
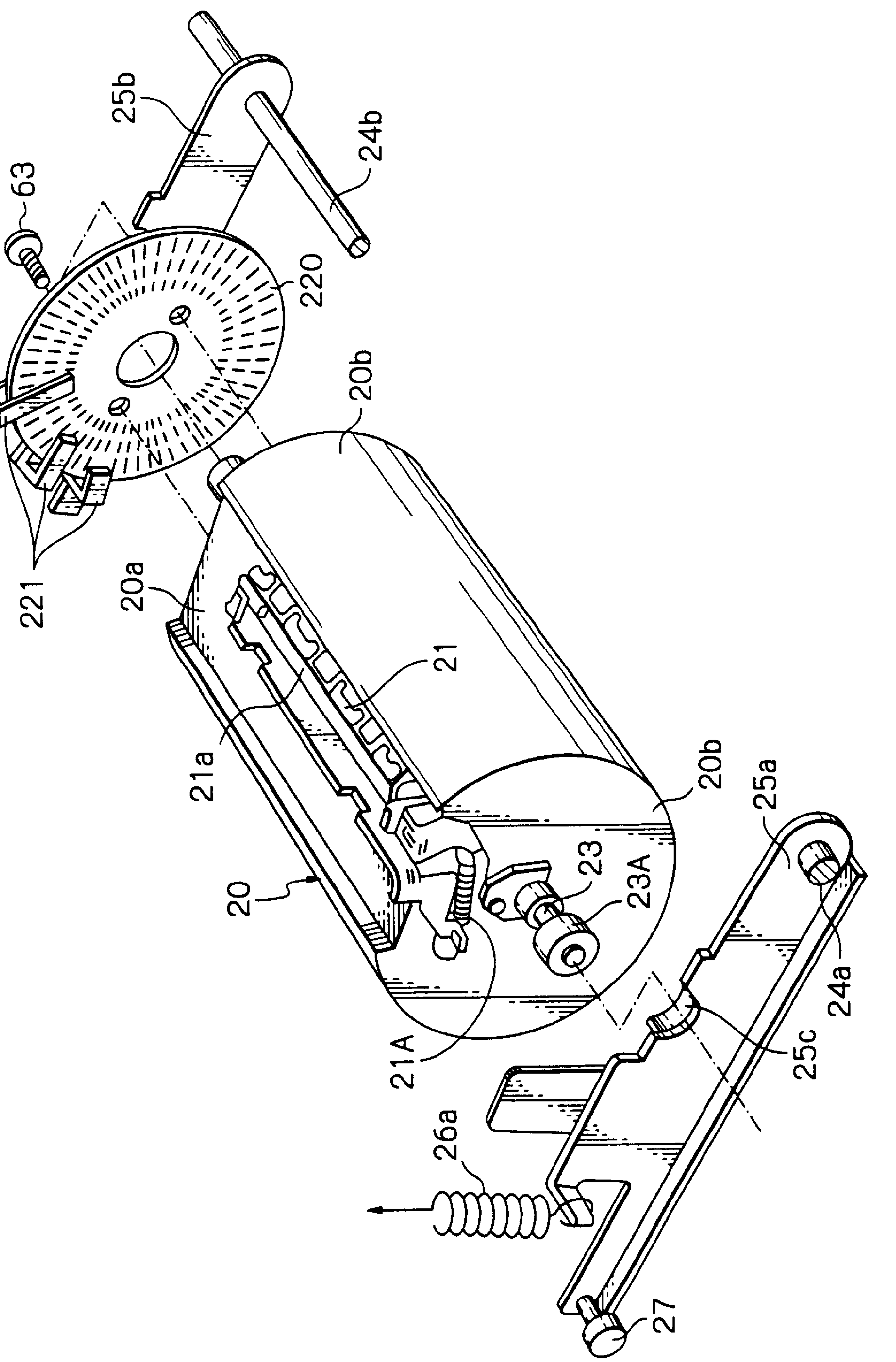

4
S48
UNCOUPLE INTERMEDIATE CLUCH
S49
BANK SHEET FEED START SENSOR (104°) ON ?
NO
YES
S50
REPORT OF TURN-ON OF BANK SHEET FEED START SENSOR (104°) FROM PRINTER SHEET FEED CONTROLLER TO BANK SHEET FEED CONTROLLER
S51
DELAY Dd (TO PREVENT CURRENT SHEET FROM CATCHING UP WITH PRECEDING SHEET)
S52
ROTATE BANK REGISTRATION MOTOR BY DESIGNATED NUMBER OF STEPS
S53
STOP BANK REGISTRATION MOTOR
S54
UNCOUPLE REGISTRATION CLUTCH
S55
TO BANK SHEET FEED CONDITION MANAGEMENT ROUTINE

Fig. 32


63
25b
24b
220
20b
26b
221
20a
21
21a
20b
25a
23
23A
20
24a
25c
21A
26a
27

SHEET FEEDING DEVICE FOR A PRINTER

BACKGROUND OF THE INVENTION

The present invention relates to a sheet feeding device for a printer, particularly a stencil printer including an ink drum with a master wrapped therearound and a press drum one of which is pressed against the other during printing.

A thermal digital stencil printer or similar printer extensively used today includes an ink drum capable of rotating at a variable speed in accordance with an input print speed with a master wrapped therearound. A press roller, or pressing means, is pressed against the ink drum relatively to the ink drum with the intermediary of a sheet. A pair of registration rollers, or registering means, feed the leading edge of a sheet toward a print position between the ink drum and the press roller. A pair of separation rollers and a pickup roller, or sheet feeding means, pay out the leading edge of a sheet toward the registration rollers. The sheet abuts against the registration rollers and forms a loop. Japanese Patent Laid-Open Publication No. 8-59031, for example, discloses a sheet feeding device applicable to the above printer.

Japanese Patent Laid-Open Publication No. 6-40137, for example, teaches a sheet feeding device applicable to a stencil printer of the type including a sheet bank in addition to the ink drum, press roller, registration rollers, and sheet feeding means. The sheet bank is positioned below the print position for feeding a sheet toward the registration rollers. A pair of intermediate rollers, or sheet conveying means, convey the leading edge of a sheet paid out from the sheet bank and cause it to abut against the registration in rollers and form a loop. This sheet feeding device includes a plurality of trays loaded with sheets and allows the operator to pull out desired one of the trays for replenishing sheets, standing at the front of the printer (front loading system).

In any one of the conventional printers, a main motor capable of rotating at a variable speed in accordance with the input print speed drives the ink drum. Specifically, a print speed key, or print speed setting means, is positioned on, e.g., an operation panel for allowing the operator to input desired one of a plurality of print speeds. At the time of printing, the rotation speed of the ink drum is varied in accordance with the print speed input on the print speed key (set print speed hereinafter).

The press roller may be replaced with a press drum having substantially the same diameter as the ink drum and including a sheet clamper. The press drum is rotatable at substantially the same peripheral speed as the ink drum in the opposite direction to the ink drum with the sheet damper retaining the leading edge of a sheet, so that the leading edge of the sheet can be forcibly separated from the ink drum. With the press drum, it is possible to prevent the sheet from rolling up without being separated from the ink drum, to reduce noise, and to enhance the positional accuracy of an image on a sheet in the direction of sheet conveyance (registration accuracy hereinafter).

In the printer taught in the above Laid-Open Publication No. 8-59031, the main motor drives the separation rollers and pickup roller via a belt, gears and clutches or cams. This kind of driveline is undesirable because the peripheral speed of the separation rollers and that of the pickup roller are dependent on a print speed varying every moment in accordance with the set print speed or, e.g., the extension of the belt due to aging, backlashes of the gears, and so forth. As a result, the amount of the loop varies from one print speed to another print speed. It follows that particularly when the print speed is low, the slip of the sheet on the separation rollers and pickup roller is aggravated, making the amount of feed short. The short amount of feed causes the sheet to skew or prevents it from being fed. Further, when the print speed is high, the sheet produces noise when straightened, i.e., when its loop disappears because the lower separation roller does not rotate and increases the load on sheet conveyance.

On the other hand, in the printer proposed in Laid-Open Publication No. 6-40137, the trays of the sheet bank each are provided with a respective separation roller, a pickup roller and other rollers for conveyance. A sheet feed motor implemented by a stepping motor drives such rollers of the sheet bank. The sheet feed motor is so controlled as to increase the sheet conveying speed of, e.g., the separation roller by 0% to 25% in accordance with five consecutive print speeds by way of example, taking account of, e.g., the slip of a sheet being conveyed toward the registration rollers. However, when the sheet conveying speed of, e.g., the separation roller is simply increased, a stable loop is not achievable. Therefore, at a low print speed, the slip of the sheet on the separation roller and other rollers is aggravated and makes the amount of feed short, resulting in the skew or the feed failure of the sheet.

At a high print speed, a sheet forms an excessive loop and produces noise when the loop disappears because the separation pad is fixed and increases the load on sheet conveyance. Moreover, as the above document shows in FIG. **1**, transport paths extending from the top and bottom trays of the sheet bank are sharply curved. Therefore, when the print speed is high, the sheet produces noise when sliding on guides forming the above transport paths. The above document therefore does not set a sheet conveying speed in consideration of noise of the entire printer.

The conventional sheet bank does not include registering means independent of the registration rollers of the printer body for conveying the leading edge of a sheet toward the registration rollers at a preselected timing. The present invention applies the above problems discussed in relation to the formation of a loop to the exclusive registering means of the bank also.

Technologies relating to the present invention are also disclosed in, e.g., Japanese Patent Laid-Open Publication No. 9-216448, Japanese Patent Publication No. 5-32296, Japanese Utility Model Publication No. 5-18342, Japanese Patent Laid-Open Publication Nos. 9-30714, 5-124737, 5-221536, 6-40137, 6-144600, 7-137851, 2-265825 and 10-35911, and U.S. patent application Ser. No. 09/025,037 which issued as U.S. Pat. No. 6,098,536 and Ser. No. 09/042,615 which issued as U.S. Pat. No. 5,931,090.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a sheet feeding device for a printer capable of feeding a sheet at a preselected speed without regard to a print speed varying every moment due to various factors particular to an ink drum driveline or a set print speed, i.e., whether a set print speed is higher than a standard print speed or lower than the same, thereby obviating the short loop of a sheet which would result in the skew or feed failure of a sheet and reducing noise at print speeds lower than the standard print speed and used more often than the other print speeds.

It is another object of the present invention to provide a sheet feeding device for a printer capable of stably forming a preselected amount of loop and surely obviating the skew and feed failure of a sheet by recognizing the position of the leading edge of the sheet without regard to a load on sheet conveyance dependent on the configuration of a transport path and sheet size or even when the slip of the sheet on sheet conveying means increases.

It is still another object of the present invention to provide a sheet feeding device for a printer capable of preventing a sheet from rolling up, reducing noise, and increasing registration accuracy.

It is yet another object of the present invention to provide a sheet feeding device for a printer capable of reducing the skew, lateral misregistration and crease of a sheet fed from a sheet bank, feeding a sheet toward the registering means of a printer body at a constant timing, and correcting the variation of the amount of sheet feed ascribable to the slip of a sheet occurring between the sheet bank and the registering means.

It is a further object of the present invention to provide a sheet feeding device for a printer capable of enhancing the stability and reliability of a sheet feed timing toward registering means.

In accordance with the present invention, a sheet feeding device for a printer includes an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, a pressing member pressed against the ink drum relative to the ink drum with the intermediary of a sheet, a registering device for feeding the leading edge of the sheet toward a print position between the ink drum and the pressing member, a bank sheet feeding section positioned below the print position, and a sheet conveying device for conveying the sheet fed from the bank sheet feeding section toward the registering device. A print speed setting device sets a print speed such that the ink drum rotates in accordance with a set print speed included in the plurality of print speeds. A sheet conveyance drive source independent of a driveline assigned to the ink drum for driving the sheet conveying device. The sheet conveyance drive source drives the sheet conveying device in such a manner as to set up a constant sheet conveying speed without regard to the set print speed set via the print speed setting device.

Also, in accordance with the present invention, a sheet feeding device for a printer includes an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, a pressing member pressed against the ink drum relative to the ink drum with the intermediary of a sheet, a registering device for feeding the leading edge of the sheet toward a print position between the ink drum and the pressing member, and a bank sheet feeding section for conveying the sheet toward the registering device. A bank registering device is included in the bank sheet feeding section independently of the registering device for feeding the leading edge of the sheet toward the registering device. A bank sheet conveying device feeds the leading edge of the sheet toward the bank registering device such that the leading edge of the sheet abuts against the bank registering device and forms a loop. A bank sheet conveyance drive source independent of a driveline assigned to the ink drum drives the bank sheet conveying device. A print speed setting device sets a print speed such that the ink drum rotates in accordance with a set print speed included in the plurality of print speeds. The bank sheet conveyance drive source drives the bank sheet conveying device in such a manner as to set up a constant sheet conveying speed without regard to the set print speed set via the print speed setting device.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description taken with the accompanying drawings in which:

FIG. **1** is a front view showing a stencil printer and a bank sheet feeding section embodying the present invention;

FIG. **2** is a fragmentary enlarged front view of the illustrative embodiment;

FIG. **3** is a plan view showing an auxiliary sheet feeding section included in the illustrative embodiment;

FIG. **4** is a fragmentary sectional front view of the auxiliary sheet feeding section;

FIG. **5** is a fragmentary sectional view showing a portion where a sheet fed from the auxiliary sheet feeding section forms a loop;

FIG. **6** is a fragmentary sectional view showing a portion where a sheet fed from the bank sheet feeding section forms a loop;

FIG. **7** is a fragmentary exploded isometric view showing a structure for mounting control parts around a press drum included in the illustrative embodiment;

FIG. **8** is a plan view of the structure shown in FIG. **7**;

FIG. **9** is an isometric view showing a home position sensor responsive to the home position of an ink drum included in the illustrative embodiment;

FIG. **10** is an isometric view showing a structure for mounting control parts around a pair of registration rollers included in the illustrative embodiment;

FIG. **11** is an exploded isometric view showing a structure for mounting control parts around an arm associated with a press drum included in the illustrative embodiment;

FIG. **12** is a front view showing the angular position of a sheet damper included in the illustrative embodiment and varying in accordance with the rotation of the press drum;

FIGS. **13**A and **13**B are views each showing a particular angular position of the press drum;

FIG. **14** is a fragmentary isometric view showing a sheet size sensing mechanism associated with, e.g., an auxiliary tray included in the illustrative embodiment;

FIG. **15** is a fragmentary front sectional view showing the bank sheet feeding section;

FIG. **16** is a fragmentary isometric view showing a sheet feed drive mechanism included in the bank sheet feeding section;

FIG. **17** is a fragmentary plan view of an operation panel included in the illustrative embodiment;

FIG. **18** is a plan view showing specific pictures to appear on an LCD (Liquid Crystal Display) mounted on the operation panel;

FIG. **19** is a block diagram schematically showing a sheet feed control system with which a first to a third embodiment of the present invention are practicable;

FIG. **20** is a timing chart demonstrating the sheet feeding operation of the entire printer representative of the first embodiment;

FIG. **21**A is a timing chart representative of the feed of a sheet from the auxiliary sheet feeding section in accordance with the first embodiment;

FIGS. **21**B and **21**C are views associated with FIG. **21**A and showing the auxiliary sheet feeding section;

FIG. **22** is a chart showing how the number of pulses and the pulse width are varied in the first embodiment;

FIG. **23** is a front view showing how sheet feeding means and intermediate rollers convey a sheet at the beginning of drive;

FIG. **24** is a fragmentary front view demonstrating how a sheet is caused to form a loop between registration rollers and the sheet feeding means or between the registration rollers and the intermediate rollers in the first embodiment;

FIG. **25** is a front view showing how the registration rollers convey a sheet at the beginning of drive or how the intermediate rollers convey it during assist rotation in the first embodiment;

FIG. **26** is a fragmentary front view demonstrating the conveyance of the leading edge of a sheet toward a sheet damper included in the first embodiment;

FIG. **27** is a fragmentary front view representative of the conveyance of a sheet at the initial stage of printing in accordance with the first embodiment;

FIGS. **28** and **29** are flowcharts demonstrating a specific sheet feeding operation available with the first embodiment;

FIGS. **30** and **31** are flowcharts representative of the feed of a sheet in the bank sheet feeding section in accordance with the first embodiment; and

FIG. **32** is an exploded isometric view showing a structure for mounting parts around the ink drum in accordance with a modification of the first embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the printer in accordance with the present invention and modifications thereof will be described hereinafter with reference to the accompanying drawings. In the embodiments and modifications thereof, parts and elements identical in function and configuration are designated by identical reference numerals, and a repetitive description thereof will not be made in order to avoid redundancy. As for parts or elements provided in pairs, but not needing distinction, only one of them will be described.

Referring to FIG. **1** of the drawings, a printer to which the present invention is applicable is shown and implemented as a stencil printer by way of example. As shown, the stencil printer, generally **100**, includes a bank sheet feeding section **200** positioned below a printing section, which will be described, included in the printer **100**. A printer frame **100**A and a bank frame **200**A constitute the body of the printer **100** and the body of the bank **200**, respectively.

As shown in FIGS. **1** and **2**, the printer **100** includes a hollow cylindrical ink drum **1** around which a master or cut stencil **2** is to be wrapped. A master discharging section **18** is arranged at the left-hand side of the ink drum **1** for peeling off a used master existing on the ink drum **1**. A master making section **19** is located at the right-hand side of the ink drum **1** for making the master **2** while conveying it. A document reading section **3** is arranged above the master discharging section **18**, ink drum **1** and master making section **19** in order to read a document image. An ink feeding device **22** is disposed in the ink drum **1** for feeding ink to the master **2** wrapped around the drum **1**. A press drum **20** is positioned below the ink drum **1** and includes a sheet damper or sheet retaining means **21** for retaining the leading edge of a sheet P. The press drum **20** presses the sheet P against the master **2** existing on the ink drum **1**. A sheet feeding device embodying the present invention is located at the right-hand side of the press drum **20** and includes an auxiliary sheet feeding section **28** representative of a plurality of sheet feeding sections. The sheet feeding device feeds the leading edge of a sheet P toward the sheet damper **21** of the press drum **20**. A sheet discharging section **80** is arranged at the left-hand side of the press drum **20**.

As shown in FIGS. **1**, **2**, **9** and **12**, the ink drum **1** is made up of a porous hollow cylinder and a laminate mesh screen, not shown, wrapped around the cylinder. The ink drum **1** is rotatably mounted on a shaft **11**. A main motor **150** causes the ink drum **1** to rotate at a speed variable in accordance with a print speed via a drive transmission mechanism which will be described specifically later. The main motor **150** implemented by a DC motor by way of example does not transmit its rotation to the sheet feed driveline and sheet conveyance driveline of the auxiliary sheet feeding section **28** or those of the bank sheet feeding section **200**. The main motor **150** is therefore smaller in size than the conventional main motor.

As shown in FIG. **2**, an encoder **151** is mounted on the output shaft **150***a* of the main motor **150** and implemented by an incremental photo-rotary encoder. An encoder sensor **152** is mounted on the a printer frame **100**A in the vicinity of the encoder **151**. Specifically, the encoder sensor **152** is implemented by a transmission type optical sensor including a light emitting portion and a light-sensitive portion which sandwich the encoder **151** at a preselected distance from the encoder **151**. The encoder **151** rotates together with the main motor **150** while outputting preselected pulses. The encoder sensor **152** senses the pulses representative of the rotation speed of the ink drum **1**. The resulting output of the encoder sensor **152** is used to control the rotation speed of the ink drum **1**.

A master damper **12** is mounted on the outer periphery of the ink drum **1** and angularly movable about a shaft **12***a* for clamping the leading edge of the master **2** produced from the master making section **19**. A stage, not shown, is also mounted on the outer periphery of the ink drum **1** and extends in the direction axial direction of the ink drum **1**. The stage is formed of a ferromagnetic material. The master clamper **12** is positioned to face the stage and has a magnet adhered to its surface facing the stage. When the ink drum **1** reaches a preselected angular position, an opening and closing device, not shown, causes the master clamper **12** to open and then close.

As shown in FIG. **9**, a home position sensor **72** is mounted on the printer frame **100**A to face the rear end wall **1***a* of the ink drum **1**. The home position sensor **72** is responsive to a home position H.P (see FIG. **13**A) assigned to the ink drum **1**. The home position sensor **72** is implemented by a transmission type optical sensor including a light emitting portion and a light-sensitive portion. An interrupter **73** protrudes outward from the rear end wall **1***a* so as to selectively interrupt the optical path of the home position sensor **72**.

As shown in FIG. **2**, the master making section **19** includes a shaft **10***b* supporting a stencil roll **10** such that a stencil, also labeled **2**, can be paid out from the roll **10**. The stencil roll **10** includes a core **10***a*. A platen roller **9** conveys the stencil **2** while paying it out from the roll **10**. A thermal head **17** is movable into and out of contact with the platen roller **9**. A pair of cutter members **4** are located downstream of the platen roller **9** in the direction in which the stencil **2** is paid out, and cuts the stencil **2** at a preselected length. A pair of rollers **5***a* and **5***b* convey the leading edge of the stencil or master **2** toward the master clamper **12**.

The platen roller **9** has its shaft rotatably supported. A pulse motor **6** causes the platen roller **9** to rotate at a preselected peripheral speed, so that the platen roller **9** conveys the stencil **2** while pressing it against the thermal head **17**.

The thermal head **17** includes a plurality of heating elements arranged in an array in the widthwise direction of the stencil **2**. A conventional moving mechanism, not shown, moves the head **17** into and out of contact with the platen roller **9**. The head **17** selectively perforates, or cuts, the stencil **2** with heat in accordance with an image signal digitized by an analog-to-digital converter included in the document reading section **3** and processed by a master making control section not shown. As a result, an image corresponding to a document image is formed in the stencil **2**. A cutter drive motor **7** moves the upper cutter member **4** up and down via an eccentric cam **8**. When the upper cutter member **4** is moved downward, it cuts the stencil **2** in cooperation with the lower cutter member **4**.

As shown in FIG. **2**, the ink feeding device **22** includes an ink roller **13** rotatable in synchronism with and in the same direction as the ink drum **1** for feeding ink to the inner periphery of the ink drum **1**. A doctor roller **15** is positioned in parallel to the ink roller **13** and spaced from the roller **13** by a small gap, forming an ink well **16**. The shaft **11** mentioned earlier is tubular and feeds ink to the ink well **16** via apertures formed therein. The ink roller **13** and doctor roller **15** are journalled to a front and a rear side wall affixed to the shaft **11**. The ink drum **1** and ink roller **13** are spaced from each other by a small gap to allow ink transferred from the ink well **16** to the ink roller **13** to be fed to the inner periphery of the ink drum **1** by the ink roller **13**. The ink is fed under pressure from an ink pack to the hollow shaft **11** by an ink pump, although not shown specifically.

In the illustrative embodiment, the press drum **20** with the sheet clamper **21** is used as pressing means in order to increase registration accuracy relative to the sheet P, to stabilize image density, and to reduce noise during printing. As shown in FIG. **12** in detail, the press drum **20** has an outside diameter D equal to the outside diameter D of the ink drum **1**. Therefore, when the ink drum **1** completes one rotation, the press drum **20** also completes one rotation. This allows the sheet clamper **21** for clamping the sheet P to be mounted on the press drum **20**. By feeding the sheet P while causing its leading edge to abut against the sheet clamper **21**, it is possible to increase registration accuracy relative to the sheet P. In the illustrative embodiment, the press drum **20** has an outside diameter D of 180 mm and a length of 300 mm.

If the above advantage attainable with the press drum **20** is not of primary importance, the pressing means may be implemented by, e.g., a press roller smaller than the ink drum **1** and movable into contact with the ink drum **1** with the intermediary of the master **2**.

Another advantage achievable with the press drum **20** is as follows. As shown in FIG. **12**, the leading edge of the sheet P abuts against the sheet clamper **21** when the clamper **21** is brought to an angular position $\hat{1}$ (sometimes referred to as a clamp position hereinafter). Then, the sheet clamper **21** is closed to clamp the leading edge of the sheet P. As the clamper **21** clamping the paper P is moved to a position $\hat{2}$, the ink is transferred from the ink drum **1** to the sheet P. As the sheet clamper **21** is further moved to a position $\hat{3}$ (sometimes referred to as an unclamp position hereinafter) past of the position $\hat{2}$, the clamper **21** is opened to release the leading edge of the sheet P. This prevents the sheet P from rolling up on the ink drum **1** due to the adhesion force of the ink.

As shown in FIGS. **2**, **7** and **8**, the press drum **20** includes end walls **20*b*** affixed to a shaft **23**. As shown in FIGS. **7** and **11**, arms **25*a*** and **25*b*** are respectively positioned outside of the opposite end walls **20*b***, and each includes a bearing support portion **25*c*** and a cam follower **27** implemented by a bearing. The shaft **23** is rotatably supported by the bearing support portions **25*c*** via bearings **23**A mounted on its axially opposite ends, allowing the press drum **23** to rotate. The printer frame **100**A includes a front and a rear side wall although not shown specifically. A shaft **24*a*** is affixed to the front side wall. The arm **25*a*** has its one end supported by the shaft **24*a*** via a bearing not shown. Likewise, the arm **25*b*** has its one end supported by a shaft **24*b*** supported by the rear side wall via a bearing not shown. The shafts **24*a*** and **24*b*** are coaxial with each other.

A drive gear, not shown, is affixed to the end portion of the shaft **24*b*** inside of the arm **25*b*** for transmitting rotation to the press drum **20**. A driven gear, not shown, is affixed to the end of the shaft **23** adjoining the arm **25*b*** and held in mesh with the drive gear. A toothed pulley, not shown, is affixed the shaft **24*b*** outside of the arm **25*b*** for transmitting the rotation of the ink drum **1**. A toothed belt, not shown, is passed over the above toothed pulley and a toothed pulley affixed to the end wall **1*a*** of the ink drum **1**. Another pulley is mounted on the above end plate **1*a*** coaxially with the toothed pulley. In this configuration, the rotation of the main motor **150** is transmitted to the driven gear via the pulleys, belt and drive gear. The press drum **20** is therefore rotated in the same direction (counterclockwise) as and in synchronism with the ink drum **1**.

The press drum **20** has a contour made up of a cylindrical portion capable of contacting the ink drum **1** and a generally D-shaped recess **20*a*** capable of preventing the drum **20** from interfering with the master clamper **12** of the drum **1**. In the illustrative embodiment, the press drum **20** consists of a core formed of synthetic resin for a light weight configuration and a nitrile rubber layer covering the core. The nitrite rubber layer reduces the irregular rotation of the press drum **20**.

The sheet clamper **21** is positioned in the recess **20*a*** of the press drum **20** and includes a magnet not shown. A shaft **21*a*** is disposed in the recess **20*a*** and supports the base end of the clamper **21**. A spring **21**A constantly biases the clamper **21** in a direction in which the clamper **21** tends to close. A cam, not shown, causes the clamper **21** to open at a preselected timing and then close after clamping the leading edge of the sheet P, thereby retaining the sheet P on the press drum **20**.

When the sheet P is, e.g., a plain paper or a thin paper, the sheet clamper **21** clamps the leading edge portion of the sheet P over about 2 mm. On the other hand, when the sheet P is, e.g., a relatively thick paper, the clamper **21** does not clamp the leading edge of the sheet P. Should the clamper **21** clamp, e.g., a relatively thick paper, it would fail to fully close due to the elasticity of the sheet P and would thereby cause the leading edge of the sheet P to hit against the master **2** or the mesh screen present on the ink drum **1**, causing the ink to fly about.

The press drum **20** is selectively moved into or out of contact with the ink drum **1** by the following moving means. The moving means includes a pair of springs **26*a*** and **26*b*** and a pair of cams, not shown, in addition to the two arms **25*a*** and **25*b*** and two cam followers **27** stated earlier. The arms **25*a*** and **25*b*** are angularly movable about the shafts **24*a*** and **24*b***, respectively, moving the press drum **20** toward or away from the ink drum **1**. The two cam followers **27** are rotatably mounted on the ends of the arms **25*a*** and **25*b***, respectively. The springs **26*a*** and **26*b*** constantly bias the arms **25*a*** and **25*b***, respectively, toward the ink drum **1**. The cams each contact one of the two cam followers **27**.

The above two cams each are connected to the ink drum **1** and main motor **150** by a toothed belt, not shown, and rotated in synchronism with the ink drum **1**. Each cam has a contour contacting the associated cam follower such that the outer periphery of the press drum **20** except for the recess **20***a* is pressed against the preselected porous region of the ink drum **1** where the master clamper **12** is absent. A pressure canceling mechanism, not shown, is mounted on the printer frame **100**A and includes a solenoid not shown. When an error occurs in the conveyance of the sheet P or during master making operation, the pressure canceling mechanism releases the cams and cam followers **27** and therefore the ink drum **1** and press drum **20**. In this manner, the press drum **20** is movable about the shafts **24***a* and **24***b* between a position where it is pressed against the ink drum **1** and a position where it is spaced from the ink drum **1**.

The springs **26***a* and **26***b* generate a force for pressing the press drum **20** against the ink drum **1**. The springs **26***a* and **26***b* are respectively anchored to the arms **25***a* and **25***b* in order to cause the above force to evenly act on the ink drum **1**.

The driveline including the main motor **150**, the moving means and so forth described above are shown in, e.g., FIGS. **1**–**5** of Japanese Patent Laid-Open Publication No. 9-216448 mentioned earlier.

The sheet discharging section **80** adjoining the left end of the press drum **20** includes a peeler **81** for peeling off the sheet P from the press drum **20**. A belt **85** is passed over two rollers **83** and **84** for conveying the sheet removed by the peeler **81**. A suction fan, not shown, holds the sheet P on the belt **85** by suction. The belt **85** is driven by, e.g., a motor at a speed higher than the peripheral speed of the ink drum **1**. A tray **82** is positioned at the left-hand side of the sheet discharging section **80** for receiving the sheet or printing P.

The sheet feeding device including the auxiliary sheet feeding section **28** is arranged at the right-hand side of the press drum **20**. As shown in FIGS. **1**–**4**, the sheet feeding device includes an upper and a lower registration roller **33***a* and **33***b*, respectively. The registration rollers, or registering means, **33***a* and **33***b* cause the leading edge portion of the sheet P to form a loop and then convey the leading edge toward a print position between the ink drum **1** and the press drum **20**. The auxiliary sheet feeding section **28** feeds the sheets P toward the registration rollers **33***a* and **33***b*.

A substantially vertical transport path RZ extend between the registration rollers **33***a* and **33***b* and the bank sheet feeding section **200** and includes a pair of intermediate rollers or conveying means **55***a* and **55***b*. The intermediate rollers **55***a* and **55***b* drive the leading edge of the sheet P fed from the sheet feeding section **200** toward the registration rollers **33***a* and **33***b*. On abutting against the registration rollers **33***a* and **33***b*, this sheet P forms a loop. A sheet feed motor or conveyance drive means **74** drives the intermediate rollers **55***a* and **55***b*. A substantially horizontal transport path RX extends between the auxiliary sheet feeding device **28** and the registration rollers **33***a* and **33***b*. Guides **38**, **39** and **40** are arranged in the transport path RX for guiding the leading edge of the sheet P to the registration rollers **33***a* and **33***b* and then to the sheet clamper **21** of the press drum **20**.

A leading edge sensor **51** is positioned in the vicinity of a position where the above two transport paths RZ and RZ join each other for sensing the leading edge of the sheet P fed from the intermediate rollers **55***a* and **55***b*. A registration sensor **52** is positioned on the transport path RX between the registration rollers **33***a* and **33***b* and the press drum **20** for sensing the leading edge of the sheet P. The leading edge sensor **51** is also responsive to the leading edge of the sheet P fed from the auxiliary sheet feeding section **28** via the transport path RX.

As shown in FIGS. **1**–**4**, the auxiliary sheet feeding section **28** includes an elevatable tray **31** on which the sheets P are stacked. Sheet feeding means picks up the sheets P on the tray **31** one by one while feeding them toward the registration rollers **33** and **33***b*. The front end of the sheet stack P on the tray **31** is positioned by a front plate **35**.

In the illustrative embodiment, a registration motor **58** independent of the main motor **150** drives the registration rollers **33** and **33***b* in place of the conventional sector gear system.

The sheet feeding means includes a pickup roller **30** for paying out the sheets P stacked on the tray **31** and a separation roller **32** and a separation pad **34** (FIG. **5**) cooperating to separate the top sheet P from the under lying sheets P. The sheet feeding means **29** is driven by the previously mentioned sheet feed motor **74** independent of the main motor **150** in place of the conventional sector gear system.

The tray **31** is elevatable such that the pickup roller **30** constantly contacts the top sheet P with a preselected pressure capable of conveying the sheet P. The tray **31** allows sheets to be fed even by hand, i.e., allows a broad range of sheets to be used. Up to 500 sheets of size A3 or A4 can be stacked on the tray **31**. A structure for implementing manual sheet feed is taught in, e.g., Japanese Utility Model Laid-Open Publication No. 5-18342 by way of example.

As shown in FIGS. **3** and **14**, a pair of side fences **43***a* and **43***b* are positioned on the tray **31** and movable toward and away from each other in the widthwise direction Y of the sheets P. The side fences **43***a* and **43***b* position the opposite sides of the sheets P in accordance with the size of the sheets P. FIG. **14** shows a sheet size sensing mechanism specifically. The sheet size sensing mechanism determines the size of the sheets P in interlocked relation to the movement of the side fences **43***a* and **43***b* in the widthwise direction Y. The mechanism includes a pinion **46** rotatably mounted on a stationary member positioned on the bottom of the tray **31**. A rack **45** is formed at one edge of the lower portion of the side fence **43***a* and held in mesh with the pinion **46**. Likewise, a rack **44** is formed at one end of the lower portion of the side fence **43***a* and held in mesh with the pinion **46**. The racks **45** and **44** face each other, as illustrated. An interrupt wall **44***a* protrudes downward from the other edge of the lower portion of the side fence **43***b* opposite to the rack **44** and is formed with a plurality of notches. Two lateral size sensors **48***a* and **48***b* are mounted on the above stationary member at a preselected distance from each other such that the interrupt wall **44***a* selectively aligns with the sensor **48***a* or **48***b*. Longitudinal size sensors **49** are also mounted on the stationary member and spaced from each other at a preselected distance in a direction of sheet feed X.

The lateral size sensors **48***a* and **48***b* each are implemented by a transmission type optical sensor having a light emitting portion and a light-sensitive portion. The size of the sheets P in the widthwise direction Y is determined on the basis of the outputs of the sensors **48***a* and **48***b* with which the interrupt portion **44***a* selectively aligns. The lengthwise size sensors **49** each are implemented by a reflection type optical sensor responsive to the size of the sheets P in the direction of sheet feed X. The sensors **48***a*, **48***b* and **49** constitute a sensor group **50**. A sheet feed control unit, which will be described later, includes a CPU (Central Processing Unit) which determines the size of the sheets P on the basis of the combination of size data output from the sensor group **50**. This kind of sheet size sensing system is taught in, e.g., Japanese Patent Laid-Open Publication No. 9-30714 mentioned earlier. Of course, the illustrative embodiment is practicable with any other suitable sheet size sensing system.

The bank sheet feeding section **200** includes trays **143** and **145**, as will be described specifically later. Sheet size sensing mechanisms similar to the above sheet size sensing mechanism are also arranged on the trays **143** and **145** and include sensor groups **50-1** and **50-2**, respectively. The sensor groups **50-1** and **50-2** will not be described specifically in order to avoid redundancy.

As shown in FIGS. **2**. **4** and **6**, the substantially horizontal transport path RX is delimited by the guides **38**, **39** and **40**. The upstream end of the guide **38** in the direction of sheet feed X is curved upward. In this configuration, the sheet P fed by the sheet feeding means in the direction X abuts against the portion of the guide **38** just upstream of the nip between the registration rollers **33***a* and **33***b*, forming a loop PA shown in FIG. **5**.

The guide **40** is bent obliquely downward from the portion of the horizontal transport path RX adjacent to the registration rollers **33***a* and **33***b*. The guide **40** forms the upper portion of the substantially vertical transport path RZ in combination with intermediate guides **41** and **42** facing the guide **40**. The end portions of intermediate guides **41** and **42** facing each other are curved away from the guide **40**, as illustrated. The bank **200** sheet feeding section includes sheet feeding means **29-1** and **29-2**. When the sheet feeding means **29-1** or **29-2** feeds the sheet P to the downstream side in a direction of sheet feed Z via a plurality of rollers, which will be described later, the leading edge of the sheet P abuts against the above portion just upstream of the nip between the registration rollers **33***a* and **33***b* and forms a loop PA, as shown in FIG. **6**.

The intermediate rollers **55***a* and **55***b* mentioned earlier are positioned in the upper portion of the vertical transport path RZ for causing the leading edge of the sheet P fed from the bank **200** to abut against the registration rollers **33***a* and **33***b*. More specifically, the rollers **55***a* and **55***b* cause the leading edge of the sheet to abut against the portion just upstream of the nip between the registration rollers **33***a* and **33***b* and form the loop PA. As shown in FIGS. **3** and **4**, the right intermediate roller **55***a*, as viewed in FIGS. **2** and **4**, is implemented as a drive roller made up of three roller elements. The roller elements are mounted on a single shaft **55***c* for reducing the crease of a thin sheet. The other intermediate roller **55***b* is implemented as a driven roller constantly pressed against the intermediate roller **55***a* by a spring or similar biasing means. The intermediate roller **55***b* is also made up of three roller elements although not shown in FIG. **3**. The shaft **55***c* and a shaft, not shown, on which the roller **55***b* is mounted are rotatably supported by a front panel and a rear panel included in the printer body via roller bearings **86**.

A drive system for selectively driving the intermediate rollers **55***a* and **55***b* or the sheet feeding means **29** will be described with reference to FIGS. **3** and **4** together with a more detailed configuration of the feeding means **29**. One-way clutches **67** are interposed between the separation roller **32** and a shaft **32***a* on which the roller **32** is mounted and between the pickup roller **30** and a shaft **30***a* on which the roller **30** is mounted. Toothed pulleys **32**A and **30**A are mounted on the shafts **32***a* and **30***a*, respectively. A timing belt **37** is passed over the pulleys **32**A and **30**A. When the one-way clutches **67** are coupled, the pickup roller **30** and separation roller **32** are rotated clockwise, as indicated by an arrow in FIG. **4** for feeding the sheets P one by one. That is, the pickup roller **30** and separation roller **32** are rotatable only in the clockwise direction.

The shafts **30***a* and **32***a* supporting the pickup roller **30** and separation roller **32**, respectively, are rotatably supported by a generally U-shaped arm **35**A whose bottom is open. The pickup roller **30** is angularly movable about the shaft **32***a* over a preselected angle due to its own weight and the weight of the arm **35**A. The shaft **32***a* protrudes outward from the rear side panel **89***b* and rotatably supported by the panel **89***b* via the roller bearing **86**. A toothed driven pulley **56** is mounted on the end of the end of the shaft **32***a* protruding from the rear panel **89***b*. A one-way clutch **56**A is interposed between the driven pulley **56** and the shaft **32***a* and allows the shaft **32***a* to rotate only in the clockwise direction, as viewed in FIG. **4**, when coupled.

The sheet feed motor **74** is implemented by a stepping motor and independent of the driveline assigned to the ink drum **1** and including the main motor **150**. The operator of the printer **100** is capable of setting a desired print speed on print speed keys **96** (see FIG. **17**). When the desired print speed is higher than a standard print speed, the motor **74** drives the intermediate rollers **55***a* and **55***b* at a speed matching with the desired print speed. When the desired print speed is lower than the standard print speed, the motor **74** drives the rollers **55** and **55***b* at a speed matching with the standard print speed. The motor **74** therefore serves not only as sheet feed drive means for driving the separation roller **32** and pickup roller **30**, but also as sheet conveyance drive means for driving the intermediate rollers **55***a* and **55***b*.

As shown in FIGS. **3** and **4**, the sheet feed motor **74** is mounted on a motor bracket **74**A affixed to the rear panel **89***b* by screws. Toothed drive pulleys **75***a* and **75***b* are mounted on the output shaft of the motor **74**. A timing belt **57** is passed over the driven pulley **56** and drive pulley **75***b*.

A drive gear **78** and a toothed driven pulley **76** are mounted on a shaft **76***a* in the vicinity of the drive pulley **75***a*. A timing belt **77** is passed over the driven pulley **76** and drive pulley **75***a*. A driven gear **79** is mounted on one end of the shaft **55***c* of the intermediate roller **55***a* and held in mesh with the drive gear **78**. A one-way clutch **79**A is interposed between the shaft **55***c* and the driven gear **79**. The one-way clutch **79**A causes the intermediate roller **55***a* to rotate clockwise for conveying the sheet P via the driven gear **79** when coupled.

When the auxiliary sheet feeding section **28** is to feed a sheet P, the sheet feed motor **74** is rotated clockwise or forward in FIG. **4**. The rotation of the motor **74** is transferred to the shaft **32***a* via the drive pulley **75***b*, timing belt **57**, driven pulley **56** and one-way clutch **56**A which is coupled then. The rotation of the shaft **32***a* is transmitted to the separation roller **32** via the one-way clutch **67**, which is coupled then, causing the roller **32** to rotate clockwise. At the same time, the rotation of the shaft **32***a* is transferred to the pulley **32**A and then to the shaft **30***a* via the timing belt **37**, pulley **30**A and one-way clutch **67** which is coupled then, causing the pickup roller **30** to rotate clockwise. The separation roller **32** and pickup roller **30** both rotating clockwise feed the top sheet P from the auxiliary tray **31** toward the registration rollers **31**. Although the rotation of the motor **74** is transferred from the drive pulley **75***a* to the driven gear **79** via the timing belt **77**, driven pulley **76** and drive gear **78**, the one-way clutch **79**A is not coupled and causes the driven gear **79** to simply idle. Therefore, the rotation of the motor **74** is not transmitted to the intermediate rollers **55** and **55***b*.

On the other hand, when the bank sheet feeding section **200** is to feed a sheet P, the motor **74** is reversed, i.e., rotated in the counterclockwise direction in FIG. **4**. This rotation of the motor **74** is transmitted to the shaft **55***c* via the drive pulley **75***a*, timing belt **77**, driven pulley **76**, drive gear **78**, driven gear **79** and one-way clutch **79**A which is coupled then. As a result, the intermediate roller **55***a* is rotated clockwise while the intermediate roller **55***b* contacting the roller **55***a* is rotated counterclockwise. The intermediate rollers **55***a* and **55***b* cooperate to convey the sheet P fed from the sheet feeding section **200** toward the registration rollers **33***a* and **33***b*. In this case, although the rotation of the motor **74** is transferred to the driven pulley **56** via the drive pulley **75***b* and timing belt **57**, the one-way clutch **56**A is not coupled and causes the driven pulley **56** to simply idle. The rotation of the motor **74** is therefore not transferred to the shaft **32***a*, so that the separation roller **32** and pickup roller **30** do not rotate.

As stated above, a single motor **74** implements both of the conveyance drive means assigned to the intermediate rollers **55***a* and **55***b* and sheet feed drive means. That is, the motor **74** is reversibly driven to selectively rotate the intermediate rollers **55***a* and **55***b* or the separation roller **32** and pickup roller **30**. This obviates the need for two drive motors respectively assigned to a pair of intermediate rollers and a separation roller and a pickup roller, as taught in, e.g., Japanese Patent Laid-Open Publication No. 6-40137. It follows that the illustrative embodiment is free from layout limitations ascribable to two motors and therefore saves space and cost.

An upper intermediate sensor **53** is mounted on the intermediate guide **42** between the leading edge sensor **51** and the intermediate rollers **55***a* and **55***b* for sensing the leading edge of the sheet P. The bank sheet feeding section **200** includes a pair of bank registration rollers **106***a* and **106***b*. A lower intermediate sensor **54** is mounted on the lower portion of the intermediate guide **42** on the vertical transport path RZ between the intermediate rollers **55***a* and **55***b* and the bank registration rollers **106***a* and **106***b*. The lower intermediate sensor **54** is also responsive to the leading edge of the sheet P. The intermediate sensors **53** and **54** each are implemented by a reflection type optical sensor including a light emitting portion and a light-sensitive portion. As partly shown in FIG. **5**, the intermediate guide **42** is formed with holes for passing light issuing from the light emitting portions of the sensors **53** and **54**.

A sheet jam occurred on the upstream portion of the vertical transport path RZ including the intermediate rollers **55***a* and **55***b* is detected on the basis of the output of the intermediate sensor **53**. The lower intermediate sensor **54** determines whether or not the sheet P is fed from the bank sheet feeding section **200** within a preselected period of time, and senses a sheet jam occurred on the path RZ upstream of the intermediate rollers **55***a* and **55***b*.

The registration motor **58** for driving the registration roller **33***b* is also implemented by a stepping motor. As shown in FIG. **4**, a drive pulley **58**A is mounted on the output shaft of the motor **58**. A timing belt **59** is passed over the drive pulley **58**A and a driven pulley **33**A mounted on the shaft **33***c* of the registration roller **33***b*. The drive pulley **58**A and driven pulley **33**A both are toothed pulleys engaged with the timing belt **59** without slipping.

As shown in FIG. **10**, the upper registration roller **33***a* is made up of three roller elements mounted on the shaft **33***c* for reducing the crease of a thin sheet. While the upper guide **38** is formed with five holes **38***a* in an array, the three roller elements of the registration roller **33***a* are respectively rotatably received in three intermediate holes **38***a*. A moving mechanism, not shown, moves the registration roller **33***a* into and out of contact with the registration roller **33***b* which is implemented as five roller elements, not shown in FIG. **10**.

As shown in FIGS. **1** and **10**, in the illustrative embodiment, the leading edge sensor **51** is mounted on the upper guide **38** at a position 19 mm upstream of the center of the shaft **33***c* in the direction of sheet feed X. Likewise, in the illustrative embodiment, the registration sensor **52** is mounted on the upper guide **38** at a position 19 mm downstream of the center of the shaft **33***c* in the above direction X. The sensors **51** and **52** both are reflection type optical sensors each including a light emitting portion and a light-sensitive portion. As shown in FIGS. **5** and **6**, the guide **38** is formed with holes for passing light issuing from the light transmitting portions and light reflected from the sheet P.

The leading edge sensor **51** senses a jam occurred in the direction of horizontal sheet feed X including the sheet feeding means **29** or at the upstream side in the direction of vertical sheet feed Z. In addition, when the leading edge of the sheet P fed from the auxiliary sheet feeding section **28** or the bank sheet feeding section **200** abuts against the portion just upstream of the nip between the registration rollers **33***a* and **33***b*, the leading edge sensor **51** joins in the adjustment of the loop PA which the sheet P is expected to form. The registration sensor **52** also responsive to the leading edge of the sheet P senses a sheet jam occurred in the direction X including the registration rollers **33***a* and **33***b* or at the upstream side of the direction Z.

The moving mechanism assigned to the upper registration roller **33***a* includes a pair of roller arms **33***d* supporting the opposite ends of the shaft **33***c* at one end. The roller arms **33***d* are affixed at the other end to a shaft **36** rotatable by a preselected angle about its own axis. A cam follower, not shown, for canceling a pressure is mounted on the rear end of the shaft **36** and includes a bearing. A cam, not shown, is mounted on the printer frame **100**A and slidably contacts the cam follower. A spring, not shown, constantly biases the upper registration roller **33***a* toward the lower registration roller **33***b*.

In the illustrative embodiment, the above cam is driven by the main motor **150** via gears or similar drive transmitting members. Alternatively, such a mechanism moving mechanism may be replaced with a solenoid, stepping motor or similar electrical mechanism in order to further reduce the load to act on the main motor **150**, as stated previously.

Assume that the ink drum **1** and press drum **20** each rotate via the positions to be described with reference to FIGS. **13**A and **13**B while the sheet P is conveyed. FIG. **13** shows the ink drum **1** and press drum **20** held in their home positions H.P. When the press drum **20** is in its home position H.P, the recess **20***a* is positioned on the top of the drum **20** and faces the master clamper **12** of the ink drum **1**. The clockwise rotation of the ink drum **1** from the home position H.P is represented by an angle θ. The counterclockwise rotation of the press drum **20** from the home position H.P is represented by an angle θ'. It is to be noted that the ink drum **1** and press drum **20** each are removable from the printer body **100**A when held in the home position H.P.

The operation of the moving mechanism associated with the upper registration roller **33***a* is as follows. As shown in FIG. **20**, in the illustrative embodiment, the pressure for pressing the upper registration roller **33***a* against the lower registration roller **33***b* is applied (ON) when the ink drum **1** is rotated to a position $\theta=257.5°$ and then canceled (OFF) when it is rotated to a position $\theta=57.5°$ (417.5°). After the sheet clamper **21** has clamped the leading edge of the sheet P, the registration roller cam is rotated such that the bearing of the cam follower contacts the projection of the cam. As a result, the registration roller **33***a* is raised away from the lower registration roller **33***b* against the action of the spring. The roller **33***a* is continuously spaced from the roller **33***b* until the trailing edge of the above sheet P fully moves away from the rollers **33***a* and **33***b*.

Referring again to FIG. **1**, the bank sheet feeding section **200** is removably positioned beneath the printer frame **100**A via its bank frame **200**A. The bank frame **200**A accommodates an upper and a lower sheet feeding section **201** and **202** therein. Guides, which will be described, form a lower portion of the vertical transport path RZ. A pair of bank registration rollers **106***a* and **106***b*, a bank registration sensor **135**, a pair of intermediate rollers **118***a* and **118***b* and a bank feed sensor **136** are sequentially arranged in this order toward the bottom of the bank frame **200**A.

As shown in FIGS. **1** and **15**, the upper sheet feeding section **201** includes an upper tray unit **144** including a tray **143** and raising and lowering means. The raising and lowering means causes the tray **143** to move, in a horizontal position, up and down between an upper limit position locating the top of a sheet stack P loaded thereon at a sheet feed position and a lower limit position. An upper limit sensor **137** is responsive to the upper limit position of the top of the sheet stack P. A lower limit sensor **138** is responsive to the lower limit position of the tray **143**. Sheet feeding means **29-1** feeds the top sheet P from the tray **143** while separating it from the underlying sheets P. A sheet size sensing mechanism includes the sensor group **50-1** stated earlier.

The upper tray **143** is implemented by sheet metal and forms a part of the tray unit **144** which is removable from the bank frame **200**A via the front end of the frame **200**A in the direction perpendicular to a direction of sheet feed **X1**, i.e., perpendicular to the sheet surfaces of FIGS. **1** and **15**. The upper tray unit **144** includes a casing **144**A on which the upper tray **143** is mounted together with other structural parts. The casing **144**A includes a front wall **144***a* for positioning the front edge of the sheet stack P below the sheet feeding means **29-1**.

In the illustrative embodiment, the tray **143** is expected to be loaded with sheets P of size A**3** or A**4** and up to 1,000 sheets in terms of plain papers. Of course, sheets of any other size can be stacked on the tray **143**, as needed.

Alternatively, the upper tray unit **144** may be implemented as a sheet feeding device taught in any one of Japanese Patent Laid-Open Publication Nos. 5-124737, 5-221536, 6-144600 and 7-137851 mentioned earlier. Sheet feeding devices disclosed in these documents each use a front loading system which allow the operator to perform various operations including a sheet replenishing operation, standing at the front of the device. In addition, the devices each selectively effect tandem sheet feed allowing sheets to be replenished without interrupting sheet feed under way or non-tandem sheet feed.

Use may also be made of a sheet feeding device taught in Japanese Patent Application No. 10-199188 and having the following construction. A first tray is movable up and down with a stack of sheets. Sheet feeding means sequentially feeds the sheets from the first tray in a preselected direction. A second tray is positioned substantially parallel to the first tray in the horizontal direction and loaded with a stack of sheets. Shifting means is capable of shifting the entire sheet stack from the second tray to the first tray. Sheets greater in size than at least the sheets to be stacked on the first tray or the second tray can be stacked over the first and second trays and fed by the above sheet feeding means. Raising and lowering means causes the first tray to move up and down in a horizontal position. When the sheets of great size are stacked over the first and second trays, interlocking means raises the second tray in a substantially horizontal position in interlocked relation to at least the elevation of the first tray. In FIGS. **1** and **15**, the upper tray unit **144** and tray **143** are shown as being bisected by phantom lines in order to show the outline of the tandem sheet feed.

The sheet feeding means **29-1** includes a pickup roller **30**. The upper limit sensor **137** is responsive to the position of the pickup roller **30** where it contacts the top sheet P on the tray **143** with an adequate pressure and pays it out. The sensor **137** is implemented by an interruption type optical sensor made up of a light emitting portion and a light-sensitive portion. The sensor **137** includes a feeler, not shown, affixed to the arm **35**A, FIG. **4**, and angularly movable to contact the top sheet P. An interrupter, not shown, is interlocked to the feeler and selectively interrupts the optical path between the light emitting portion and the light-sensitive portion. The sensor **137** is mounted on the bank frame **200**A in the vicinity of the pickup roller **30**. The sensor **137** may be identical in configuration with, e.g., an optical sensor **PS2** shown in FIG. **3** of Laid-Open Publication No. 2-265825 mentioned earlier.

The lower limit sensor **138** is located at a preselected position in the bank frame **200**A and implemented by a reflection type optical sensor made up of a light emitting portion and a light-sensitive portion. While the light emitting portion emits light toward one side wall of the tray **143**, the light-sensitive portion receives the resulting reflection from the side wall.

As shown in FIGS. **1** and **15**, a lower sheet feeding section **202** includes a lower tray unit **146** including a tray **145** and raising and lowering means. The raising and lowering means causes the tray **145** to move, in a horizontal position, up and down between an upper limit position locating the top of a sheet stack P loaded thereon at a sheet feed position and a lower limit position. An upper limit sensor **139** is responsive to the upper limit position of the top of the sheet stack P. A lower limit sensor **140** is responsive to the lower limit position of the tray **145**. Sheet feeding means **29-2** feeds the top sheet P from the tray **145** while separating it from the underlying sheets P. A sheet size sensing mechanism includes the sensor group **50-2** stated earlier.

The lower tray **145** is implemented by sheet metal and forms a part of the lower tray unit **146** which is removable from the bank frame **200**A via the front end of the frame **200**A in the direction perpendicular to a direction of sheet feed **X1**, i.e., perpendicular to the sheet surfaces of FIGS. **1** and **15**. The lower tray unit **146** includes a casing **146**A on which the tray **145** is mounted together with other structural parts. The casing **146**A includes a front wall **146***a* for positioning the front edge of the sheet stack P be low the sheet feeding means **29-2**.

In the illustrative embodiment, the tray **145** is expected to be loaded with sheets P of size A3 or A4 and up to 500 sheets in terms of plain papers. Of course, sheets of any other size can be stacked on the tray **145**, as needed.

The sheet feeding means **29-2** also includes a pickup roller **30**. The upper limit sensor **139**, like the upper limit sensor **137**, is responsive to the position of the pickup roller **30** where it contacts the top sheet P on the tray **145** with an adequate pressure and pays it out. The sensor **139** is mounted on the bank frame **200**A in the vicinity of the pickup roller **30**.

The lower limit sensor **140** is located at a preselected position in the bank frame **200**A and senses the lower limit position of the tray **145** with the same configuration and operation with the lower limit sensor **138**.

The raising and lowering means included in the upper sheet feeding means **201** is driven by an upper up-down motor **141** shown only in FIG. **19** and may be implemented by a wire type elevation mechanism shown in, e.g., FIGS. **3** and **4** of Laid-Open Publication No. 6-40137 mentioned earlier. The raising and lowering means included in the lower sheet feeding means **202** is driven by a lower up-down motor **142** also shown only in FIG. **19** via a wire type elevation mechanism. The up-down motors **141** and **142** are implemented by DC motors. Of course, use may be made of a pantograph type elevation mechanism using X arms and taught in Laid-Open Publication No. 10-199188 mentioned earlier.

The auxiliary sheet feeding section **28** also includes raising and lowering means similar to the above raising and lowering means and sensors similar to the upper limit sensor **139** and lower limit sensor **140**.

As shown in FIG. **15**, the lower portion of the vertical transport path RZ includes a pair of guides **127** respectively connectable to the guide **40** and intermediate guide **42** of the printer body **100**A. A pair of upper guides **128** guide the sheet P paid out from the sheet feeding means **29-1** of the upper sheet feeding section **201**.

A pair of lower guides **129** are branched off the upper guides **128** and extend downward for guiding the sheet P paid out from the sheet feeding means of the lower sheet feeding section **202**.

The bank registration rollers **106***a* and **106***b* are positioned on the vertical transport path PZ downstream of the sheet feeding means **29-1** and **29-2** in the direction of vertical sheet feed Z. The rollers **106***a* and **106***b* feed the leading edge of the sheet P toward the registration rollers **33***a* and **33***b* disposed in the printer body at a preselected timing. The rollers **106***a* and **106***b* are unique to the bank sheet feeding section **200** and used to obviate the skew, crease and lateral misregistration of the sheet P ascribable to the long transport path to the registration rollers **33***a* and **33***b*. The rollers **106***a* and **106***b* are different from the rollers **33***a* and **33***b* in that they slightly bite the leading edge of the sheet P fed thereto in order to prevent it from falling due to its own weight. Another difference is that the rollers **106***a* and **106***b* are constantly held in contact with each other by a spring not shown.

The bank registration sensor **135** is positioned on the path RZ upstream of the bank registration rollers **106***a* and **106***b* and implemented by a reflection type sensor made up of a light emitting portion and a light-sensitive portion. The sensor **135** senses the leading edge and trailing edge of the sheet P to thereby determine whether or not the sheet P has reached the registration rollers **106***a* and **106***b* within a preselected period of time. Also, the sensor **135** serves to detect a sheet jam occurred on the path RZ upstream of the registration rollers **106***a* and **106***b*. In addition, the sensor **135** joins in the adjustment of a loop which the sheet P fed from the sheet feeding means **29-1** or the intermediate rollers **118***a* and **118***b* forms on abutting against the portion just upstream of the nip between the registration rollers **106***a* and **106***b*.

The intermediate rollers **118***a* and **118***b* are positioned on the path RZ between the sheet feeding means **29-1** and **29-2** for conveying the sheet P paid out from the sheet feeding means **29-2** to the downstream side of the path RZ. The bank feed sensor **136** is positioned on the path RZ upstream of the intermediate rollers **118***a* and **118***b* and implemented by a reflection type optical sensor made up of a light emitting portion and a light-sensitive portion. By sensing the leading edge and trailing edge of the sheet P, the sensor **136** determines whether or not the leading edge of the sheet P has reached the intermediate rollers **118***a* and **118***b* within a preselected period of time. In addition, the sensor **136** detects a sheet jam occurred on the path RZ between the sheet feeding means **29-2** and the intermediate rollers **118***a* and **118***b*.

As stated above, the sheet feeding means **29-1** and intermediate rollers **118***a* and **118***b* play the role of bank sheet feeding means for feeding the leading edge of the sheet P toward the bank registration rollers **106***a* and **106***b* and causing it to form a loop on abutting against the rollers **106***a* and **106***b*.

FIG. **16** shows a bank sheet feed drive mechanism **125** for causing the sheets P to be sequentially fed from the bank sheet feeding section **200**. As shown, the sheet feed drive mechanism **125** includes a bank registration roller drive mechanism **125**A for driving the bank registration rollers **106***a* and **106***b*. A sheet feeding section drive mechanism **125**B selectively drives the pickup roller **30** and a separation roller **32** included in the upper sheet feeding means **29-1**, the intermediate rollers **118***a* and **118***b* or the pickup roller **30** and a separation roller **32** included in the lower sheet feeding means **29-2**. It is to be noted that the directions of rotation of the various structural elements to be described hereinafter are the directions as seen from the right in FIG. **16**.

The bank registration roller drive mechanism **125**A includes a reversible bank registration motor or bank registration drive means **101** for driving the bank registration rollers **106***a* and **106***b*. A gear train for transmitting the rotation of the motor **101** to the shaft **106***c* of the registration roller **106***b* includes a drive gear **102** mounted on the output shaft of the motor **101**, an idle gear **103** meshing with the drive gear **102**, and a driven gear **105** meshing with the idle gear **103**. A registration clutch **104** is interposed between the driven gear **105** and the above shaft **106***c* for selectively interrupting the transfer of the rotation of the motor **101** transmitted to the driven gear **105**.

The motor **101** is implemented by a stepping motor. The idle gear **103** is journalled to a bank side wall **126**. The shaft **106***c* of the registration roller **106***b* is rotatably supported by the side wall **126** via a roller bearing not shown. The registration clutch **104** is implemented by an electromagnetic clutch.

The sheet feeding section drive mechanism **125**B includes a reversible bank sheet feed motor **107** for selectively driving the separation roller **32** and pickup roller **30** of the upper sheet feeding means **29-1** or those of the lower sheet feeding means **29-2** or the intermediate rollers **118***a* and **118***b*. An upper gear train, which will be described later, transfers the forward rotation (clockwise) of the motor **107** to the shaft **32***a* of the separation roller **32** of the upper sheet feeding means **29-1**. A one-way clutch **110**A interposed between intermediate gears **109***a* and **109***b* and a drive pulley **110** coaxial with the gears **109***a* and **109***b*. The one-way clutch **110**A transfers clockwise rotation when coupled. An intermediate gear train, which will also be described later, transmits the reverse rotation (counterclockwise) of the motor **107** to the shaft **118***c* of the intermediate roller **118***b*. An intermediate clutch **117** is interposed between the shaft **118***c* of the intermediate roller **118***b* and the driven gear **116** for selectively interrupting the transfer of the rotation of the motor **107**. A timing belt **118**A is passed over the drive pulley **110** and driven pulley **119**. A lower gear train, which will also be described later, transmits the reverse rotation (counterclockwise) of the motor **107** to the shaft **32***a* of the separation roller **30** of the lower sheet feeding means **29-2**. A sheet feed clutch **123** is interposed between the shaft **32***a* of the separation roller **32** of the lower sheet feeding means **29-2** for selectively interrupting the transfer of the rotation of the motor **107**.

As stated above, the motor **107** selectively plays the role of bank sheet conveyance drive means or bank sheet feed drive means independent of the driveline assigned to the ink drum **1**. The bank sheet conveyance drive means drives the upper sheet feeding means **29-1** and intermediate rollers **118***a* and **118***b*. The bank sheet feed drive means drives the separation roller **32** and pickup roller **30** of the upper sheet feeding means **29-1** or those of the lower sheet feeding means **29-2**. In addition, the motor **107** drives the sheet feeding means **29-1** or the intermediate rollers **118***a* and **118***b* in accordance with the desired print speed input on the print speed keys **96**. Specifically, if the desired print speed is higher than the previously mentioned standard print speed, the motor **107** causes the upper sheet feeding means **29-1** or the intermediate rollers **118***a* and **118***b* to convey the sheet P at a speed matching with the desired print speed. If the desired print speed is lower than the standard speed, the motor **107** causes the sheet feeding means **29-1** or the rollers **118***a* and **118***b* to convey the sheet P at a speed matching with the standard print speed.

The upper gear train includes a drive gear **108** mounted on the output shaft of the motor **107**. An intermediate gear **109***a* is held in mesh with the drive gear **108**. A drive pulley **110** and an intermediate gear **109***b* are coaxial with the intermediate gear **108**. An idle gear **111** is held in mesh with the intermediate gear **109***b*. A small diameter idle gear **112***a* is held in mesh with the idle gear **111**. A large diameter idle gear **112***b* is coaxial with the idle gear **112***a*. A driven gear **113** is mounted on the end of the shaft **32***a* of the separation roller **32** included in the upper sheet feeding means **29-1** and held in mesh with the above idle gear **112***b*.

The intermediate gears **109***a* and **109***b*, idle gear **111**, small diameter idle gear **112***a* and large diameter idle gear **112***b* each are journalled to the bank side wall **126** via a respective shaft. The shaft **32***a* of the separation roller **32** of the upper sheet feeding means **29-1** is journalled to the bank side wall **1265** via a roller bearing not shown.

The intermediate gear train includes a small diameter idle gear **114***a* meshing with the drive gear **108**, a large diameter idle gear **114***b* coaxial with the idle gear **114***a*, an idle gear **115** meshing with the idle gear **114***b*, and a driven gear **116** mounted on the end of the shaft **118***c* of the intermediate roller **118***b* and meshing with the idle gear **115**. The small diameter idle gear **114***a*, large diameter idle gear **114***b* and idle gear **115** each are journalled to the bank side wall **126** via a respective shaft. The shaft **118***c* of the intermediate roller **118***b* is journalled to the bank side wall **1265** via a roller bearing not shown.

The lower gear train includes an intermediate gear **120** coaxial with the driven pulley **119**, a small diameter idle gear **121***a* meshing with the intermediate gear **120**, a large diameter idle gear **121***b* coaxial with the idle gear **121***a*, and driven gear **122** mounted on the end of the shaft **32***a* of the separation roller **32** of the lower sheet feeding means **29-2** and meshing with the idle gear **121***b*. The intermediate gear **120**, small diameter idle gear **121***a* and large diameter idle gear **121***b* each are journalled to the bank side wall **126** via a respective shaft. The shaft **32***a* of the separation roller **32** of the lower sheet feeding means **29-2** is journalled to the bank side wall **126** via a roller bearing not shown.

The intermediate clutch **117** and sheet feed clutch **123** are electromagnetic clutches.

The sheet feeding section drive mechanism **125**B is operated as follows. To feed the sheet P from the upper sheet feeding means **29-1**, the motor **107** is rotated, e. g., clockwise in FIG. **16**. The rotation of the motor **107** is transferred to the shaft **32***a* of the separation roller **32** of the upper sheet feeding means **29-1** via the upper gear train. As a result, the shaft **32***a* and therefore the separation roller **32** and pickup roller **30** are rotated clockwise, as described with reference to FIGS. **3** and **4**. The separation roller **32** and pickup roller **30** cooperate to pay out only the top sheet P from the tray **143**. At this instant, the intermediate gear **109***a* is rotated counterclockwise, so that only the shafts of the intermediate gears **109***a* and **109***b* rotate counterclockwise due to the action of the one-way clutch **110**A. Therefore, the rotation of the motor **107** is not transmitted to the drive pulley **110**.

To feed the sheet P from the lower sheet feeding means **29-2**, the motor **107** is rotated in the opposite direction, e.g., counterclockwise in FIG. **16**. Then, the intermediate gear **109***a* is rotated clockwise with the result that the shafts of the intermediate gears **109***a* and **109***b* and drive pulley **110** are integrally rotated clockwise due to the action of the one-way clutch **110**A. In this condition, the rotation of the motor **107** causes the shaft **32***a* of the separation roller **32** of the lower sheet feeding means **29-2** to rotate clockwise via the lower gear train. Consequently, the separation roller **32** and pickup roller **30** rotate clockwise, as described with reference to FIGS. **3** and **4**. At the same time, the intermediate gears **109***a* and **109***b* are rotated clockwise with the result that the shaft **32***a* of the separation roller **32** of the upper sheet feeding means **29-1** tends to rotate counterclockwise via the upper gear train. However, the one-way clutch **67** causes only the shaft **32***a* to rotate and prevents the rotation from being transferred to the pulley **32**A. This prevents the rotation of the motor **107** from being transmitted to the separation roller **32** or the pickup roller **30**.

Arrangements for sheet feed control included in the illustrative embodiment in addition to the above sensors and motors will be described hereinafter with reference to FIGS. **2**–**19**. As shown in FIG. **2** and **7**, interrupters **68** and **69** for printer sheet feed and printer registration, respectively, are fastened to the outer surface of the rear end wall **20***b* of the press drum **20** by screws. The interrupters **68** and **69** are spaced by a preselected distance in the circumferential direction of the ink drum **20**. In addition, interrupters **70** and **71** for bank sheet feed and bank registration, respectively, are fastened to the above surface of the rear end wall **20***b* by screws and spaced by a preselected distance from each other. The interrupters **70** and **71** are positioned on a circle radially inward of a circle on which the interrupters **68** and **69** are positioned. The interrupters **68**–**71** each are formed of, e.g., stainless steel or similar sheet metal or synthetic resin and is generally L-shaped in a front view and a side elevation; the end of the letter "L" protrudes to the rear.

As shown in FIGS. **2**, **7** and **11**, a sheet feed start sensor **65** and a bank sheet feed start sensor **66** are fastened to a sensor bracket **64** by screws **63**. The sheet feed start sensor **65** faces the circle of the press drum **20** on which the printer sheet feed interrupter **68** and printer registration interrupter **69** are positioned. The bank sheet feed start sensor **66** faces the circle of the press drum **20** on which the bank sheet feed interrupter **70** and bank registration interrupter **71** are positioned. The sensors **65** and **66** are transmission type optical sensors each having a light emitting portion and a light-sensitive portion.

The printer sheet feed interrupter **68** interrupts the optical path of the sheet feed start sensor **65** when the press drum **20** i s rotated counterclockwise to a preselected position. These interrupter **68** and sensor **65** constitute sheet feed timing sensing means for determining the time when the sheet feeding means **29** of the auxiliary sheet feeding section **28** should pay out the leading edge of the top sheet P toward the registration rollers **33***a* and **33***b*. As shown in FIG. **20**, in the illustrative embodiment, the above preselected position of the press drum **20**, i.e., the position of the interrupter **68** on the press drum **20** is such that the sensor **65** turns on when the press drum **20** is rotated counterclockwise to an angular position θ' of 194°. At this instant, the registration roller moving mechanism stated earlier moves the upper registration roller **33***a* away from the lower registration roller **33***b*. In this condition, the bias of the spring does not act on the sheet P.

The printer registration interrupter **69** interrupts the optical path of the sheet feed sensor **65** when the press drum **20** is rotated counterclockwise to a preselected position. These interrupter **69** and sensor **65** constitute timing sensing means for determining the time when the registration rollers **33***a* and **33***b* should drive the leading edge of the sheet P toward the sheet clamper **21** of the press drum **20**. The above preselected position of the press drum **20**, i.e., the position of the interrupter **69** on the press drum **20** is such that the sensor **65** turns on when the press drum **20** is rotated counterclockwise to an angular position θ' of 307°.

The bank sheet feed interrupter **70** interrupts the optical path of the bank sheet feed start sensor **66** when the press drum **20** is rotated counterclockwise to a preselected position. These interrupter **70** and sensor **66** serve as bank sheet feed timing sensing means for determining the time when the upper sheet feeding means **29-1** or the lower sheet feeding means **29-2** should pay out the leading edge of the sheet P. As shown in FIG. **20**, in the illustrative embodiment, the above preselected position of the press drum **20**, i.e., the position of the interrupter **70** on the press drum **20** is such that the sensor **66** turns on when the press drum **20** is rotated counterclockwise to an angular position θ' of 0° (home position of the press drum **20**).

The bank registration interrupter **71** interrupts the optical path of the bank sheet feed start sensor **66** when the press drum **20** is rotated counterclockwise to a preselected position. These interrupter **71** and sensor **66** constitute bank registration timing sensing means for determining the time when the registration rollers **106***a* and **106***b* should drive the leading edge of the sheet P toward the registration rollers **33***a* and **33***b*. In the illustrative embodiment, the above preselected position of the press drum **20**, i.e., the position of the interrupter **71** on the press drum **20** is such that the sensor **66** turns on when the press drum **20** is rotated counterclockwise to an angular position θ' of 104°.

As shown in FIGS. **2**, **7** and **8**, an encoder **60** is fastened to the rear wall **20***b* of the press drum **20** by screws **63** via two spacers **62**. In the illustrative embodiment, the encoder **60** is implemented by a single channel, incremental photo-encoder formed with a number of radial slits, as illustrated. As shown in FIGS. **2**, **8** and **11**, an encoder sensor **61** is fastened to the inner surface of the arm **25***b* in the vicinity of the encoder **60** via the previously mentioned sensor bracket **64**. The encoder sensor **61** sandwiches the peripheral portion of the encoder **60** at a preselected distance. The encoder **60** and encoder sensor **61** constitute a pulse encoder for sensing a change in the rotation speed of the press drum **20** in order to control the time when the registration rollers **33***a* and **33***b* should feed the leading edge of the sheet P toward the sheet clamper **21** of the press drum **20**.

As shown in FIGS. **7** and **8**, the encoder **60** has the same outside diameter as the press drum **20** although it is shown in a reduced scale in, e.g., FIG. **2** for the sake of illustration. The encoder **61** is not shown in FIG. **7** for the same reason, and the center bracket **64** is not shown in, e.g., FIGS. **2** and **8**.

Reference will be made to FIG. **19** for describing an operation panel **90** in detail. The operation panel **90** is mounted above the reading section **3**. As shown, the operation panel **90** includes a perforation start key **91** for setting and inputting the start of a sequence beginning with the reading of a document image and ending with the perforation of the stencil **2**. Numeral keys **93** allow, e.g., a desired number of printings to be input thereon. A print start key **92** is used to start printing the desired number of printings. An LCD **94** displays various information set or sensed during a procedure beginning with the reading of a document image and ending with printing. A tray selection and sheet size key (sheet size key hereinafter) **98** is used to select and input the sheet size of the auxiliary tray **31**, upper tray **143** or lower tray **145**. A set key **95** is used to set the above sheet size selected and input or any other information input. A left arrow key **99**B is used to select job information appearing on the LCD **94** by shifting it to the left. A right arrow key **99**C is used to select the job information by shifting it to the right. Cursor keys **99**A, i.e., four shift keys **99**A*c*, **99**A*a*, **99**A*b* and **99**A*d* are used to select the job information appearing on the LCD **94** by shifting it rightward, leftward, upward or downward. The print speed keys or print speed setting means **96** mentioned earlier are made up of an UP key **96***b* and a DOWN key **96***a*. A speed indicator **97** is implemented by a group of LEDs (Light Emitting Diodes) for displaying a print speed input on the UP key **96***b* or the DOWN key **96***a*. A kind-of-sheet key or kind-of-sheet setting means **190** is used to set the kind of sheets. LEDs **191** display the kind of sheet input on the key **190** or the kinds of sheets automatically sensed by kind-of-sheet sensors **195, 195-1** and **195-2** which will be described later. The sensors **195, 195-1** and **195-2** are indicated by phantom lines in FIG. **19** and constitute kind-of-sheet sensing means.

Every time the operator presses the sheet size input key **98**, "Sheet Size" appearing on the LCD **94** is replaced with "Cancel". In this sense, the key **98** bifunctions as a cancel key **98**A for restoring the original picture of the LCD **94**.

A specific picture to appear on the LCD **94** is shown at the top of FIG. **18**. As shown, a rectangle appearing at the top of the picture shows a job to be selected by the operator, i.e., a message "Ready to make a master and print." When the operator watching this picture presses the sheet size key **98**, the top picture is replaced with a second specific picture shown just below the top or first picture. In the second picture, "Automatic" highlighted is automatically selected, i.e., a sheet size matching with a document size is automatically set; the operator watching this picture may press any desired key. For example, when the operator presses the cancel key **98A**, the original picture at the top of FIG. **18** again appears. When the operator presses the right arrow key **99**C or the right cursor key **99**A*a*, the above second picture is replaced with a third picture shown below the second picture; this picture shows "(*A4E∛)", i.e., that the sheets P of size **A4** stacked on the "Upper Tray (tray **143**)" are selected. As the operator watching this picture presses the set key **95**, a fourth picture shown below the third picture appears.

In the speed indicator **97**, the center LED indicated by hatching is representative of "set print speed: third" which is the standard print speed usually used. This print speed is automatically set if the operator does not press the DOWN key **96***a* or the UP key **96***b*. In the illustrative embodiment, the leftmost LED to the rightmost LED, as viewed in FIG. **17**, are respectively representative of "set print speed: first" which is the lowest speed of 60 printings/min or 60 rpm (revolutions per minute), "set print speed: second" which is a speed of 75 printings/min or 75 rpm, "set print speed: third" which is a speed of 90 printings/min or 90 rpm, "set print speed: fourth" which is a speed of 105 printings/min or 105 rpm, and "set print speed: fifth" which is the highest speed of 120 printings/min or 120 rpm.

A print speed assigned to trial printing and which does not appear on the speed indicator **97** (trial print speed hereinafter) will be briefly described. Trial printing, as distinguished from regular printing to occur just after master making, is effected to fill up the perforations of the master **2** wrapped around the ink drum **1** with ink and cause the master **2** to closely adhere to the ink drum **1**. A printing produced by the trial printing is not dealt with or counted as a regular printing. The LEDs of the speed indicator sequentially turn on every time the DOWN key **96***a* or the UP key **96***b* is pressed, sequentially showing the first to fifth consecutive print speeds. The DOWN key **96***a* and UP key **96***b* adjoin the above LEDs. This allows the operator to surely see the print speed input and set.

The lamps **191**, i.e., three lamps **191***a*, **191***b* and **191***c* are respectively representative of plain papers selected, relatively thick sheets selected, and relatively thin sheets selected. Every time the operator presses the kind-of-sheet input key **190**, one of the lamps **191***a*–**191***c* turns on; the lamp **191***a* turns on when the operator presses the key **190** one time, the lamp **191***b* turns on when the operator presses the key **190** two times, or the lamp **191***c* turns on when the operator presses the key **190** three times. The lamps **191** therefore indicate the kind of sheets selected by the operator or the kinds of sheets sensed by the kind-of-sheet sensors **195**, **195-1** and **195-2**.

There are shown in FIG. **19** sheet a printer feed controller **88** and a bank sheet feed controller **148** mainly assigned to the printer **100** and bank sheet feeding section **200**, respectively. The sheet feed controllers **88** and **148** each are implemented by a microcomputer including a CPU, I/O (Input/Output) ports, a ROM (Read Only Memory), a RAM (Random Access Memory) and a timer interconnected by a signal bus, although not shown specifically. The sheet feed controllers **88** and **148** interchange ON/OFF signals, data signals and command signals with each other by serial communication.

The printer sheet feed controller **88**, more specifically its CPU, is electrically connected to the various keys of the operation panel **90** via the input port for receiving key signals therefrom. The controller **88** is electrically connected to the displays and indicators of the operation panel **80** via the output ports for controlling them by sending command signals.

The controller **88** is electrically connected to the leading edge sensor **51** via the input port and receives from the sensor **51** a signal for rotating the sheet feed motor **74** in either one of opposite directions to cause the sheet P to form a loop. Also, the controller **88** is electrically connected to the registration sensor **52** via the input port and receives from the sensor **52** a signal for compensating for the slip of the sheet P on the registration rollers **33***a* and **33***b*.

The controller **88** is electrically connected to the sheet feed start sensor **65** via the input port and receives from the sensor **65** a signal (start signal) for starting driving the sheet feed motor **74** and registration motor **58**.

The controller **88** is electrically connected to the bank sheet feed start sensor **66** via the input port and receives from the sensor **66** a signal (start signal) for starting driving the bank sheet feed motor **107** and bank registration motor **101**. This signal is transferred from the controller **88** to the other or bank sheet feed controller **148**. The sheet feed controller **88** is electrically connected to the upper and lower intermediate sensors **53** and **54** via the input port and receives from the sensors **53** and **54** data signals relating to the leading edge of the sheet P fed from the bank sheet feeding section **200**.

The controller **88** is electrically connected to the encoder sensor **61** via the input port and receives from the sensor **61** a pulse signal relating to a change in the rotation speed of the press drum **20**. The sheet feed controller **88** is electrically connected to the sensor group **50** (not shown in FIG. **19** for the simplicity of illustration) responsive to the sheet size of the auxiliary tray **31** via the input port. The controller **88** receives from the sensor group **50** data signals relating to the sheet size of the auxiliary tray **31**.

The controller **88** is electrically connected to the sheet feed motor **74** via the output port. In response to the output (start signal) of the sensor **65** representative of alignment of the interrupter **68** with the sensor **65**, the controller **88** drives the sheet feed motor **74** in the forward direction to thereby feed the leading edge of the sheet P toward the registration rollers **33***a* and **33***b*. In this sense, the controller **88** serves as sheet feed drive control means.

In response to the above signal or ON signal output from the sheet feed start sensor **65**, the sheet feed controller **88** so controls the registration motor **58** as to feed the leading edge of the sheet P in synchronism with the arrival of the sheet clamper **21** at its clamp position. Subsequently, in response to the output of the registration sensor **52**, the controller **88** so controls the registration motor **58** as to increase the speed and amount of rotation of the registration rollers **33***a* and **33***b* for compensating for the slip of the sheet P on the rollers **33***a* and **33***b* (slip correction hereinafter). In this sense, the controller **88** plays the role of registration drive control means. Specifically, the controller **88** controls the registration motor **58** by varying the number of drive pulses to be sent to the motor **58** as well as their width. After the slip correction, the controller **88** further varies the above pulse width in accordance with the output pulses of the encoder sensor **61** in order to control the motor **58** by feedback control.

Assume that the sheet P is fed from the auxiliary sheet feeding section **28**, and that the print speed input on the print speed key **96** (DOWN key **96***a* or UP key **96***b*) is the fourth or fifth speed higher than the standard print speed. Then, in response to a signal representative of the input speed, the sheet feed controller **88** drives the sheet feed motor **74** in the forward direction such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29** feed the sheet P at a speed matching with the input print speed. Assume that the print speed input on the key **96** or the print speed automatically set is lower than the standard speed (third, second or first speed or trial print speed). Then, in response to a signal representative of the print speed, the controller **88** drives the motor **74** in the forward direction such that the above separation roller **32** and pickup roller **30** feed the sheet P at a speed matching with the third or standard speed.

Assume that the sheet P is fed from the bank sheet feeding section **200**. If the print speed input on the DOWN key **96***a* or the UP key **96***b* is higher than the standard speed (fourth or fifth speed), then, in response to a signal representative of the input speed, the controller **88** drives the motor **74** in the reverse direction such that the intermediate rollers **55***a* and **55***b* convey the sheet P at a speed matching with the input print speed. If the print speed input on the key **96***a* or **96***b* or the automatically set print speed is lower than the standard speed (third, second or first speed or trial print speed), then, in response to a signal representative of the above speed, the controller **88** drives the motor **74** in the reverse direction such that the rollers **55***a* and **55***b* convey the speed P at a speed matching with the standard or third speed.

When the sheet P is fed from the auxiliary sheet feeding section **28**, the controller **88** drives the sheet feed motor **74** in the forward direction in response to the output of the leading edge sensor **51**. The motor **74** causes the leading edge of the sheet P to abut against the registration roller pairs **33***a* and **33***b* and form a preselected loop.

Further, when the sheet P is fed from the bank sheet feeding section **200**, the controller **88** drives the above motor **74** in the reverse direction in response to the output of the leading edge sensor **51**. The motor **74** causes the leading edge of the sheet P to abut against the registration rollers **33***a* and **33***b* and form a preselected loop.

On the other hand, the bank sheet feed controller **148** assigned to the bank sheet feeding section **200** is electrically connected to the upper and lower size sensor groups **50-1** and **50-2** of the bank **200** via its input port. The controller **148** transfers size signals output from the sensor groups **50-1** to **50-2** to the sheet feed controller **88** assigned to the printer **100**.

The controller **148** is electrically connected to the bank registration sensor **135** and bank feed sensor **136** via the input port and receives therefrom data signals relating to the leading edge of the sheet P.

The controller **148** is electrically connected to the upper limit sensor **137** and lower limit sensor **138** associated with the upper the sheet P at a speed matching with the third or standard speed.

Assume that the sheet P is fed from the lower sheet feeding section **202**, and that the print speed input on the key **96***a* or **96***b* is higher than the standard speed (fourth or fifth speed). Then, in response to a signal representative of the above speed and transferred from the printer sheet feed controller **88**, the controller **148** drives the motor **107** in the reverse direction such that the separation roller **32** and pickup roller **30** of the lower sheet feeding means **29-2** and intermediate rollers **118***a* and **118***b* convey the sheet P at a speed matching with the input print speed. If the input print speed or the automatically set print speed is lower than the standard speed (third, second or first speed or trial print speed), then, in response to a signal representative of the above speed and transferred from the printer sheet feed controller **88**, the controller **148** drives the motor **107** in the reverse direction such that the above separation roller **32**, pickup roller **30** and intermediate rollers **118***a* and **118***b* convey the sheet P at a speed matching with the third or standard speed.

Assume that the sheet P is fed from the tray **143** of the upper sheet feeding section **201**. Then, in response to the output of the bank registration sensor **135**, the controller **148** drives the motor **107** in the forward direction. The motor **107** causes the leading edge of the sheet P fed by the separation roller **32** and pickup roller **30** of the sheet feeding means **29-1** to abut against the registration rollers **106***a* and **106***b* and form a preselected loop. Assume that the sheet P is fed from the tray **145** of the lower sheet feeding section **202**. Then, sheet feeding section via the input port and receive therefrom ON/OFF signals relating to the upper and lower limit positions of the upper tray **143**. Likewise, the controller **148** is electrically connected to the upper limit sensor **139** and lower limit sensor **140** associated with the lower sheet feeding section via the input port and receive therefrom ON/OFF signals relating to the upper and lower limit positions of the lower tray **145**. With the signals received from the sensors **139** and **140**, the controller **148** controls the lower up-down motor **142**.

The controller **148** is electrically connected to the bank sheet feed motor **107** via the output port. Assume that the sheet P is fed from the upper sheet feeding section **201**, and that the print speed input on the DOWN key **96***a* or the UP key **96***b* is higher than the standard speed (fourth or fifth speed). Then, in response to a signal representative of the input print speed and transferred from the printer sheet feed controller **88**, the controller **148** drives the bank sheet feed motor **107** in the forward direction such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29-1** convey the sheet P at a speed matching with the input print speed. Assume that the input print speed or the automatically set print speed is lower than the standard speed (third, second or first speed or trial print speed). Then, in response to a signal representative of the above speed and transferred from the printer sheet feed controller **88**, the controller **148** drives the motor **107** in the forward direction such that the above separation roller **32** and pickup roller **30** convey in response to the output of the registration sensor **135**, the controller **148** drives the motor **107** in the reverse direction. The motor **107** causes the leading edge of the sheet P fed by the intermediate rollers **118***a* and **118***b* to abut against the registration rollers **106***a* and **106***b* and form a preselected loop.

In response to the output of the bank sheet feed start sensor **66** received via the printer sheet feed controller **88**, the controller **148** so drives the motor **107** as to feed the leading edge of the sheet P toward the registration rollers **106***a* and **106***b*. In this sense, the controller **148** plays the role of bank sheet feed drive control means.

The controller **148** is electrically connected to the bank registration motor **101** via the output port. In response to a signal (start signal) transferred from the printer sheet feed controller **88**, the controller **148** so controls the motor **101** as to feed the leading edge of the sheet P toward the registration rollers **33***a* and **33***b*. The controller **148** therefore serves as bank registration drive control means.

The controller **148** is electrically connected to the upper up-down motor **141** via the output port. In response to ON/OFF signals received from the upper limit sensor **137** and lower limit sensor **138** of the upper sheet feeding section, the controller **148** drives the motor **141** so as to move the upper tray **143** up or down. Likewise, the controller **148** is electrically connected to the lower up-down motor **142**. In response to ON/OFF signals output from the upper limit sensor **139** and lower limit sensor **140** of the lower sheet feeding section, the controller **148** drives the lower up-down motor **142** so as to move the lower tray **145** up or down.

The controller **148** is electrically connected to the registration clutch **104** via the output port and selectively couples or uncouples it, i.e., sets up or interrupts the transmission of the output of the bank registration roller **101**. Likewise, the controller **148** is electrically connected to the intermediate clutch **117** via the output port and selectively couples or uncouples it, i.e., sets up or interrupts the transmission of the output of the bank sheet feed motor **107**. Further, the controller **148** is electrically connected to the sheet feed clutch **123** and selectively turns couples or uncouples it, i.e., sets up or interrupts the transmission of the output of the motor **107**.

The ROM of the printer sheet feed controller **88** stores the following various data and operation programs. FIGS. **20** and **21** are timing charts showing the contents of control determined by, e.g., experiments beforehand. FIG. **22** shows the contents of variable control over drive pulses to be fed to the registration motor **58** and also determined by, e.g., experiments beforehand. FIGS. **28–31** are flowcharts demonstrating operation programs. The fixed distance between the leading edge sensor **51** and the nip between the registration rollers **33***a* and **33***b* is also stored in the above ROM in terms of the number of pulses of the sheet feed motor **74**. In addition, the fixed distance between the nip between the registration rollers **33***a* and **33***b* and the nip between the press drum **20** and the ink drum **1** is stored in the ROM in terms of the number of pulses of the registration motor **58**.

Further, some different tables are stored in the above ROM. The tables include a control pattern table for controlling the sheet feed motor **74** on the basis of the set print speed and a control data table for controlling, in response to the output of the leading edge sensor **51**, the motor **74** such that the leading edge of the sheet P abuts against the registration rollers **33***a* and **33***b* and forms a preselected loop. Alternatively, the above data may suitably be stored in the ROM of the bank sheet feed controller **148**.

The ROM of the bank sheet feed controller **148** stores a control pattern table for controlling the bank sheet feed motor **107** on the basis of the set print speed. In addition, the ROM stores a control data table for controlling, in response to the output of the bank registration sensor **135**, the bank sheet feed motor **107** such that the leading edge of the sheet P abuts against the registration rollers **106***a* and **106***b* and forms a preselected loop.

The RAM of the printer sheet feed controller **88** is a work area used to temporarily store the results of calculations performed by the CPU. Also, the RAM is used to store data signals output from the sensors **51**, **52**, **65**, **66**, **53** and **54**, a data signal output from the encoder sensor **61** or data signals output from the sensor groups **50-1** and **50-2** or sensors **135** and **136** of the bank sheet feed controller **148**. The RAM of the bank sheet feed controller **148** temporarily stores data signals transferred from the printer sheet feed controller **88** or the results of calculations performed by the CPU.

The timer included in the printer sheet feed controller **88** sets delay times Da. Db, Dc, Dd, De and Df shown in FIGS. **20** and **21** while variably counting time.

It is to be noted that FIG. **19** does not show the structural elements of the drive sections to be controlled specifically. In this connection, the print speed set on the DOWN key **96***a* or the UP key **96***b* or automatically set is input not only to the CPU of the printer sheet feed controller **88** but also to, e.g., the CPU of a drum drive control unit, not shown, independent of the controller **88**. The encoder sensor **152** and home position sensor **72** are electrically connected to the drum drive control unit via an I/O port. Also, the main motor **150** and a device for braking it, not shown, are electrically connected to the drum drive control unit via a main motor driver and the above I/O port. The drum drive control unit constantly monitors the output of the encoder sensor **152** representative of the rotation speed of the ink drum **1** and press drum **20**. The control unit controls, based on the set print speed, the rotation speed of the main motor via the output port and main motor driver such that the ink drum **1** and press drum **20** rotate at the set print speed. Such a function of the control unit may, of course, be partly assigned to the printer sheet feed controller **88**.

The operation of the stencil printer **100** with the auxiliary sheet feeding section **28** will be described first. When the operator lays a document on the document reading section **3** and then presses the perforation start key **91**, the ink drum **1** held in its home position starts rotating. The master discharging section **18** peels of a used master wrapped around the ink drum **1** and discharges it. When the master clamper **12** on the ink drum **1** is brought to the substantially rightmost position in FIG. **2**, the ink drum **1** stops rotating. Then, the shaft **12***a* supporting the master clamper **12** is rotated to open the master clamper **12** away from the stage. In this condition, the ink drums **1** waits for a new master **2**.

Subsequently, the stepping motor **6** of the master making section **19** is driven to rotate the platen roller **9**. The platen roller **9** conveys the stencil **2** while paying it out from the roll **10**. In the document reading section **3**, a scanner, not shown, reads the document laid thereon and outputs an image signal representative of a document image. The image signal is digitized by the analog-to-digital converter and then processed by the master making control section to turn out a digital image signal. The heating elements of the thermal head **17** are selectively energized in accordance with the digital image signal, selectively perforating the stencil **2** with heat.

The platen roller **9** in rotation conveys the leading edge of the stencil **2** being perforated toward the master clamper **12** held in its open position. When the number of steps of the pulse motor **6** reaches a preselected number, the shaft **12***a* is rotated to close the master clamper **12** toward the stage. As a result, the master clamper **12** clamps the leading edge of the perforated part of the stencil **2**.

At the same time as the master clamper **12** clamps the stencil **2**, the ink drum **1** and press drum **20** start rotating at a peripheral speed substantially equal to the speed at which the stencil **2** is conveyed. The perforated part of the stencil **2** is therefore sequentially wrapped around the ink drum **1**. When the stencil **2** is wrapped around the ink drum **1** by a preselected length, the ink drum **1**, press drum **20** and platen roller **9** stop rotating. At the same time, the cutter motor **7** is energized to lower the upper cutter member **4** via the eccentric cam **8**, thereby cutting off the perforated part of the stencil **2**, i.e., the master **2**. Subsequently, the ink drum **1** again rotates clockwise to pull the trailing edge of the master **2** out of the master making section **19**. Consequently, the entire master **2** is wrapped around the ink drum **1**.

The conveyance of the sheet P will be described with reference made to FIGS. **20**, **21A**, **23**, **27** and **28**. FIG. **20** shows both of the sheet feed timing of the auxiliary sheet feeding section **28** and that of the bank sheet feeding section **200**. The sheet feed timings particular to the printer **100** and bank **200** are respectively shown at the left-hand side and right-hand side of FIG. **20** with respect to the angular position θ' of 0°. FIG. **21A** shows the sheet feed timing of the auxiliary sheet feeding section in detail together with the sheet feed timing substantially common to both of the sheet feeding sections **28** and **200** and following the start of rotation of the registration rollers **33***a* and **33***b*. The timing chart of FIG. **21** therefore partly overlaps with the timing chart of FIG. **20**.

As shown in FIG. **28**, first, whether or not the printer **100** is ready to start feeding a sheet P is determined (step S**1**). More specifically, whether or not the ink well **16** adequate for printing has been formed by the ink feeding device **22** and whether or not the printer **100** with such an ink well **16** can start printing when the perforation start key **91** is pressed are determined. If the answer of the step S**1** is positive (YES), whether or not a sheet P is to be fed from the bank sheet feeding section **200** is determined (step S**2**). This decision is made on the basis of the auxiliary tray **31** or the upper tray **143** or the lower tray **202** of the bank sheet feeding section **200** and a sheet size selected and set the sheet size key **98** and set key **95** or automatically set. If the answer of the step S**2** is negative (NO), meaning that a sheet P is to be fed from the auxiliary sheet feeding section **28**, a routine for feeding a sheet from the auxiliary sheet feeding section **28** is executed (step S**3**). This routine will be described specifically before a routine for feeding a sheet P from the bank sheet feeding section **200** (step S**4** and successive steps).

In the event of trial printing, the main motor **150** causes the ink drum **1** and press drum **20** to rotate at a peripheral speed matching with the automatically set print speed (sixteen printings/min or 16 rpm) assigned to trial printing.

As shown in FIGS. **20**, **21**A and **23**, when the press drum **20** reaches an angular position θ of 194°, the interrupter **68** interrupts the optical path of the sheet feed start sensor **65**. The resulting ON signal output from the sensor **65** is sent to the printer sheet feed controller **88**. Then, on the elapse of a preselected delay Da, the sheet feed motor **74** is driven in the forward direction to rotate the separation roller **32** clockwise. The separation roller **32** and pickup roller **30** rotated in the same direction as the roller **32** cooperate to feed only the top sheet P toward the registration rollers **33***a* and **33***b*. As shown in FIG. **21**B, the leading edge sensor **51** is located on the horizontal transport path RX downstream of the separation roller **32** by Xa mm. When the sensor **51** senses the leading edge of the above sheet P, it sends an ON signal to the printer sheet feed controller **88**.

The trial print speed is lower than the standard print speed, as stated earlier. Therefore, the printer sheet feed controller **88** drives the sheet feed motor **74** such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29** rotate at a conveying speed corresponding to the standard or third print speed (90 rpm), i.e., a peripheral speed of 847.8 mm/sec.

As shown in FIGS. **5** and **24**, the printer sheet feed controller **88** outputs, based on the output of the leading edge sensor **51**, a command signal causing the leading edge of the sheet P to abut against the portion just upstream of the registration rollers **33***a* and **33***b* and form a preselected amount of loop PA. As a result, a preselected number of drive pulses are fed to the sheet feed motor **74** via the previously mentioned driver, so that the sheet P is fed by Xc mm (loop adjustment). When the leading edge of the sheet P forms the above loop PA convex upward, the sheet feed motor **74** and therefore the separation roller **32** and pickup roller **30** are caused to stop rotating.

The above loop PA is confined in an experimentally determined range which obviates the skew and feed failure ascribable to the rotation of the registration rollers **33***a* and **33***b*, and reduces noise because of the adequate amount of loop. To implement the adequate loop PA, the printer sheet feed controller **88** drives the sheet feed motor **74** such that the sheet feeding means **29** feeds the sheet P by a greater amount than the bank sheet feeding section **200**.

In the illustrative embodiment, the amount of feed Xc of the sheet P is the sum of the distance of 19 mm between the nip between the registration rollers **33***a* and **33***b* and the leading edge sensor **51** and 6 mm, i.e., 25 mm in total. The printer sheet feed controller **88** translates the above amount of feed into the number of steps and then controls the sheet feed motor **74**. As a result, the motor **74** causes the separation roller **32** to feed the sheet P such that the sheet P forms the loop PA.

As stated above, the printer sheet feed controller **88** controls the sheet feed motor **74** independently of the driveline assigned to the ink drum **1** in such a manner to effect the unique loop adjustment. This successfully obviates a short loop at low print speeds without resorting to the print speed varying every moment due to the aging of a belt included in the ink drum driveline and the backlashes of gears. In addition, the sheet P is prevented from skewing or from being not fed due to the rotation of the registration rollers **33***a* and **33***b*, and can therefor stably form the expected loop.

As for the delay Da, the leading edge of a sheet having the maximum length of 447 mm moves away from the front wall **35** when the press drum **20** reaches an angular position θ' of about 200°. The delay Da should therefore preferably be 10° or above in terms of the rotation angle of the press drum **20** including a margin. With the delay Da between the time when the leading edge sensor **65** turns on and the time when the sheet feed motor **74** starts rotating, it is possible to correct a scatter among machines and to implement control with software. Further, the delay Da is useful to define the operation timing of the sheet feed motor **74** by using the ON signal which the sheet feed start sensor **65** outputs at the angular position of 194° of the press drum **20** as a trigger.

As shown in FIGS. **20**, **21**A and **25**, when the press drum **20** further rotates counterclockwise to an angular position θ' of 307°, the interrupter **69** interrupts the optical path of the sheet feed start sensor **65**. As a result, the sensor **65** sends an ON signal to the printer sheet feed controller **88**. The controller **88** drives the registration motor **58** and sheet feed motor **74** on the elapse of a preselected delay Db since the arrival of the above ON signal. The registration motor **58** causes the registration roller **33***b* to start rotating counterclockwise and convey the leading edge of the sheet P toward the sheet clamper **21** of the press drum **20**. At the same time, the sheet feed motor **74** causes the separation roller **32** to rotate at a low speed for a short period of time, thereby reducing noise produced by the sudden disappearance of the loop of the sheet P.

The above delay Db is useful to define the operation timing of the registration motor **58** by using the ON signal of the sheet feed start sensor **65** output at the angular position θ' of 307° of the press drum **20** as a trigger.

As shown in FIG. **21**C, the registration rollers **33***a* and **33***b* convey the leading edge of the sheet P abutting against the portion just upstream of the nip between the rollers **33***a* and **33***b* to the downstream side of the transport path RX by a distance of Xb mm (19 mm in the illustrative embodiment). Then, the registration sensor **52** turns on and sends an ON signal to the printer sheet feed controller **88**. At this instant, the distance between the position where the sheet P abuts against the nip between the registration rollers **33***a* and **33***b* is fixed, and therefore the count of drive pulses fed to the registration motor **58** is expected to be constant. However, the sheet P is apt to slip, particularly in the initial stage of rotation of the registration rollers **33***a* and **33***b*. The count of drive pulses is therefore apt to vary from one sheet to another sheet until the registration sensor **52** turns on. In light of this, the printer sheet feed controller **88** determines a delay of the sheet P on the basis of the count of drive pulses having been output until the turn-on of the registration sensor **52**. The controller **88** increases, based on the determined delay, the speed and amount of the subsequent rotation of the registration motor **58**, thereby correcting the slip of the sheet P.

Stated another way, assume that the printer sheet feed controller **88** counts drive pulses needed to cause the registration motor **58** to convey the sheet P until the registration sensor **62** turns on, and delivers drive pulses necessary for conveying the leading edge of the sheet P by Xd mm to the registration motor **581**. Then, the controller **88** increases the number of drive pulses, i.e., the amount of rotation of the registration motor **58** in accordance with the slip of (Xd−Xb) mm of the sheet P on the registration rollers **33***a* and **33***b*. In addition, the controller **88** reduces the width of the drive pulses in order to increase the rotation speed (pps) of the registration motor **58**.

More specifically, the distance between the registration sensor **52** and the nip between the registration rollers **33***a* and **33***b* on the horizontal transport path RX is fixed, as stated earlier. It follows that the number of drive pulses necessary for the registration motor **58** to rotate the registration roller **33***b* by an amount corresponding to the above distance is fixed. For example, assume that when the quality of the sheet P is changed, the registration sensor **52** does not turn on even after a preselected number of drive pulses have appeared since the start of rotation of the registration roller **33***b*, meaning that the sheet P has slipped. Then, the printer sheet feed controller **88** sends to the registration motor **58** a command signal for conveying the sheet by an extra amount corresponding to the difference between the preselected number of pulses and the number of pulses actually caused the registration sensor **52** to turn on. In addition, the controller **88** reduces the pulse width in order to increase the rotation speed of the motor **58**.

As shown in FIG. **22**, for the above slip correction, the printer sheet feed controller **88** varies the number of drive pulses (P_1–P_4) to be fed to the registration motor **58** and the pulse width (t_1–t_4) thereof.

After the slip correction, the printer sheet feed controller **88** controls, in accordance with the output pulses of the encoder sensor **61**, the registration motor **58** in such a manner as to convey the leading edge of the sheet P to the sheet clamper **21** brought to its clamp position. This is so-called feedback control (FBC, FIG. **21**A).

As stated above, the amount by which the sheet P is conveyed by the registration motor **58** in response to a single pulse and the amount by which the circumference of the press drum **20** is moved in response to a single pulse width of the encoder **60** are identical. For FBC, the printer sheet feed controller **88** counts a period of time necessary for a single pulse width of the encoder **60** with the timer thereof and decelerates the registration motor **58** if the above period of time increases due to, e.g., a change in the load acting on the press drum **20**. Conversely, when the period of time necessary for a single pulse of the encoder **60** decreases, the controller **88** accelerates the motor **58**.

Stated another way, the controller **88** constantly traces the irregular rotation, i.e., irregular peripheral speed of the press drum **20** in terms of changes in the pulses output from the encoder **61**. The controller **88** variably controls the rotation speed of the registration motor **58** in accordance with the variation of pulses output from the encoder **61** (FBC using the encoder **61**). At this instant, the controller **88** determines the angular position of the press drum **20** in terms of the number of pulses sensed by the encoder sensor **61** and determines the peripheral speed of the drum **20** in terms of the period of time t also sensed by the encoder sensor **61**. As shown in FIG. **22**, the controller **88** further varies the drive pulse width (t1–t4) for the registration motor **58** in order to control the motor **58** by FBC. This is successful to reduce misregistration.

The press drum **20** is rotating at a speed matching with the automatically set trial print speed. The sheet P is conveyed at a speed 1.4 times higher than the peripheral speed of the press drum **20**. When the sheet clamper **21** of the press drum **21** is about to close, the sheet P reaches the clamper **21** and obtains a speed equal to the peripheral speed of the press drum **20**.

The sheet clamper **21** of the press drum **20** is opened at a preselected timing shown in FIGS. **20** and **21**A, i.e., when the press drum **20** reaches an angular position θ' of 350.5°.

Under the above encoder FBC of the controller **88**, the registration roller **33***b* is rotated counterclockwise to, in turn, rotate the upper registration roller **33***b* clockwise via the sheet P. As a result, as shown in FIG. **26**, the loop PA (indicated by a phantom line) of the sheet P disappears. The separation roller **32** and pickup roller **30** simply follow the movement of the sheet P due to the action of the one-way clutches **67**. The leading edge of the sheet P is conveyed until it abuts against the sheet clamper **21**.

As shown in FIGS. **21**A, **26** and **27**, as soon as the leading edge of the sheet P abuts against the sheet clamper **21**, the clamper **21** is closed to grip it. In the illustrative embodiment, this occurs when the press drum **20** reaches an angular position θ' of 10° (370°). The press drum **20** therefore rotates while retaining the sheet P thereon and conveys it to the print position between the drum **20** and the ink drum **1**.

As shown in FIG. **27**, the press drum **20** is raised toward the ink drum **1** under the action of the springs **26***a* and **26***b*, forming a nip with the intermediary of the sheet P. In this condition, the press drum **20** presses the sheet P against the ink drum **1** (print pressure ON). As the sheet P is pressed against the master **2** wrapped around the ink drum **1**, the master **2** is caused to closely adhere to the ink drum **1**. At the same time, the ink is transferred to the sheet via the porous portion of the ink drum **1** and the perforations of the master **2**, producing a printing. At this instant, the ink roller **13** rotates in the same direction as the ink drum **1**. Therefore, the ink in the ink well **16** is deposited on the ink roller **13** and conveyed thereby to the inner periphery of the ink drum **1** while being regulated in amount by the doctor roller **15**.

In the meantime, the printer sheet feed controller **88** continues the FBC using the encoder. When the controller **88** determines that the registration motor **58** has rotated by an amount stored in the ROM thereof (angular position θ' of 75° (435°) in the illustrative embodiment), it deenergizes the registration motor **58** and ends FBC.

When the press drum **20** is further rotated to a sheet discharge position preceding the peeler **81** (angular position θ' of 81.2° (441.2°) in the illustrative embodiment), the sheet clamper **21** is opened. Then, the peeler **81** peels off the sheet or trial printing P from the press drum **20**. The trial printing P is then conveyed by the belt **85** to the tray **82**. The press drum **20** is released from the ink drum **1** and held in its initial position.

The operator watching the above trial printing determines whether or not the quality and position of the image are adequate. If the trial printing acceptable, the operator inputs a desired number of printings on the numeral keys **93** and then presses the print start key **92**. In response, the printer **100** repeats the sheet feed, printing and sheet discharge a number of times corresponding to the desired number of printings. In this case, because the operator has not touched the print speed keys **96**, the standard or third print speed is automatically set. The main motor **150** drives the ink drum **1** and press drum **20** at a speed corresponding to the standard speed.

Because the set print speed is lower than the standard print speed (third, second or first speed or trial print speed), the printer sheet feed controller **8** causes the sheet feed motor **74** to rotate in the forward direction as during trial printing. Therefore, the separation roller **32** and pickup roller of the sheet feeding means **29** convey the consecutive sheets P at a speed corresponding to the standard or third print speed (90 rpm), i.e., at a peripheral speed of 847.8 mm/sec. Each sheet P has the amount of its loop adjusted in the same manner as during trial printing. After the lading edge of the sheet P has been moved away from the nip between the registration rollers **33***a* and **33***b*, the above unique conveyance and printing are effected at a conveyance speed and a printing speed corresponding to the third print speed.

Assume that the operator selects the second or first print speed lower than the standard speed on the print speed key **96**. Then, the separation roller **32** and pickup roller **30** of the sheet feeding means **29** are rotated at a conveying speed corresponding to the standard or third print speed) (90 rpm), i.e., at a peripheral speed of 847.8 mm/sec as during trial printing or during standard speed operation. Again, the sheet P is fed by an amount subjected to loop adjustment. After the leading edge of the sheet P has been moved away from the nip between the registration rollers **33***a* and **33***b*, the above unique conveyance and printing are effected at a conveyance speed and a printing speed corresponding to the second or first print speed.

As stated above, the printer sheet feed controller **88** controls the sheet feed motor **74** independently of the driveline assigned to the ink drum **1** in such a manner as to effect the unique conveyance speed adjustment and loop adjustment. This successfully obviates a short loop at low print speeds without regard to the print speed varying every moment due to the aging of a belt included in the ink drum driveline and the backlashes of gears. Further, the sheet P is prevented from skewing or from being not fed due to the rotation of the registration rollers **33***a* and **33***b*, and can therefor stably form the expected loop. In addition, there can be reduced noise at the standard print speed.

Assume that the operator selects the fourth print speed higher than the standard speed on the print speed key **96**. Then, the main motor **150** rotates the ink drum **1** and press drum **20** in such a manner as to implement a print speed corresponding to the set fourth speed. The printer sheet feed controller **88** determines that the set print speed is higher than the standard speed. Then, the controller **88** drives the sheet feed motor **74** forward such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29** convey the sheet P at a speed corresponding to the set fourth print speed, i.e., at a peripheral speed of 989.1 mm/sec. Again, the sheet P is fed by an amount subjected to the previously stated loop adjustment. After the leading edge of the sheet P has been moved away from the nip between the registration rollers **33***a* and **33***b*, the above unique conveyance and printing are effected at a conveyance speed and a printing speed corresponding to the fourth print speed.

Assume that the operator selects the fifth or highest print speed on the print speed key **96**. Then, the main motor **150** rotates the ink drum **1** and press drum **20** in such a manner as to implement a print speed corresponding to the set fifth speed. The printer sheet feed controller **88** determines that the set print speed is higher than the standard speed. Then, the controller **88** drives the sheet feed motor **74** forward such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29** convey the sheet P at a speed corresponding to the set fifth print speed (120 rpm), i.e., at a peripheral speed of 1,130.4 mm/sec. Again, the sheet P is fed by an amount subjected to the previously stated loop adjustment. After the leading edge of the sheet P has been moved away from the nip between the registration rollers **33***a* and **33***b*, the above unique conveyance and printing are effected at a conveyance speed and a printing speed corresponding to the fifth print speed.

As stated above, the printer sheet feed controller **88** controls the sheet feed motor **74** independently of the driveline assigned to the ink drum **1** in such a manner as to effect the unique conveyance speed adjustment and loop adjustment. This successfully obviates a short loop at low print speeds without regard to the print speed varying every moment due to the aging of a belt included in the ink drum driveline and the backlashes of gears. Further, the sheet P is prevented from skewing or from being not fed due to the rotation of the registration rollers **33***a* and **33***b*, and can therefor stably form the expected loop.

The above delay Db between the time when the sheet feed start sensor **65** outputs an ON signal and the time when the registration motor **58** is actually driven is useful to correct scattering among machines and to facilitate control using software.

The routine including the step S**4** of FIG. **28** and successive steps and relating to the bank sheet feeding section **200** will be described with reference to FIGS. **30** and **31**. The routine begins with the printer sheet feed controller **88**. In response, the controller **88** informs the bank sheet feed controller **148** of the turn-on of the sensor **66** by serial communication (step S**33**).

Subsequently, whether or not the bank feed sensor **136** has turned on is determined (step S**34**). Specifically, by determining whether or not the trailing edge of the sheet fed before the second sheet to be fed has moved away from the bank feed sensor **136**, it is possible to prevent the second sheet from catching up with the trailing edge of the preceding sheet and jamming the transport path. If the answer of the step S**34** is YES, meaning that the trailing edge of the preceding sheet P has not moved away from the sensor **136** yet, the preceding sheet P is continuously conveyed until its trailing edge moves away from the sensor **136**, i.e., until the sensor **136** turns on. If the answer of the step S34 is NO, meaning that the trailing edge of the preceding sheet P is passing the sensor **136**, the sheet feed clutch **123** is coupled to allow the rotation of the bank sheet feed motor **107** to be transferred to the sheet feeding means **29**-**2**. At the same time, the intermediate clutch **117** is coupled to allow the rotation of the motor **107** to be transferred to the intermediate rollers **118***a* and **118***b* (steps S35 and S36).

Subsequently, the bank sheet feed motor **107** is rotated in the reverse direction in order to rotate the intermediate rollers **118***a* and **118***b* to rotate in FIG. **15**. The rollers **118***a* and **118***b* convey the trailing edge of the preceding sheet P toward the registration rollers **106***a* and **106***b* arranged on the vertical transport path RZ. At the same a step S**30** of FIG. **30**. The following description will concentrate on the third, second or first print speed or the trial print speed lower than the standard speed and set by the operator on the key **96** or automatically set. The main motor **150** drives the ink drum **1** and press drum **20** at a speed matching with the above set print speed.

First, the tray **143** of the upper sheet feeding section **201** or the tray **145** of the lower sheet feeding section **202** and a paper size thereof are selected and set on the sheet size key **98** and set key **95** or automatically set. Whether or not the tray **143** of the upper sheet feeding means **201** is selected is determined (step S**30**). If the answer of the step S**30** is NO, the lower up-down motor **142** causes the tray **145** to rise until the top of the sheet stack P on the tray **145** reaches the sheet feed position, as determined by the lower limit sensor **139** (step S31). In this condition, the lower sheet feeding section **202** is ready to feed the sheet P thereof. It is to be noted that when the tray **145** of the lower sheet feeding section **202** and the sheet size thereof are selected and set either manually or automatically, the sheet size of the tray **145** is sensed by the sensor group **50-2** beforehand. This step, however, will not be described specifically in order to avoid redundancy.

Whether or not the press drum **20** is located at its home position is determined (step S32). Specifically, when the press drum **20** reaches the angular position θ' of 0°, the interrupter **70** interrupts the optical path of the bank sheet feed start sensor **66** (YES, step S32). The resulting ON signal output from the sensor **66** is sent to time, the sheet feeding means **29-2** starts picking up the top sheet S. More specifically, the drive mechanism **125**B operates as described with reference to FIG. **16** with the result that the separation roller **32** and pickup roller **30** of the sheet feeding means **29-2** are rotated clockwise in FIG. **16** (counterclockwise in FIG. **15**). As a result, only the top sheet P is paid out from the tray **145** in the direction X1 (step S37).

The bank sheet feed controller **148** identifies the set print speed lower than the standard speed, i.e., the third, second or first speed or the trial print speed on the basis of the signal transferred from the printer sheet feed controller **88**. The controller **148** therefore drives the bank sheet feed motor **107** in the reverse direction such that the separation roller **32** and pickup roller **30** convey the sheet P at a speed corresponding to the third or standard speed (90 rpm), i.e., a peripheral speed of 847.8 mm/sec. As shown in FIG. **20**, in the step S**32**, the controller **148** drives the motor **107** on the elapse of a delay Dc since the receipt of the ON signal output from the bank sheet feed sensor **66** (rotation angle θ' of 0° of the press drum **20**).

After the step S**37**, whether or not the feed sensor **136** has turned on, i.e., whether or not the leading edge of the sheet P being paid out has reached the feed sensor **136** is determined (step S**38**). If the answer of the step S**38** is YES, meaning that the leading edge of the sheet P being paid out has moved away from the sensor **136**, the sheet feed motor **107** is driven by a designated number of steps in the reverse direction. As a result, the separation roller **32** and pickup roller **30** of the sheet feeding means **29-2** and intermediate rollers **118***a* and **118***b* are rotated by a distance of sheet conveyance corresponding to the reverse rotation of the motor **107**. Then, the motor **107** is deenergized. Thereafter, the sheet feed clutch **123** is uncoupled to interrupt the transfer of rotation from the motor **107** to the separation roller **32** and pickup roller **30**. As a result, so long as the trailing edge of the sheet P being paid out remains in contact with the two rollers **32** and **30**, the rollers **32** and **30** simply follow the movement of the sheet P (steps S38–S40).

The step S**40** is followed by a step S41 for determining whether or not the trailing edge of the preceding sheet P has moved away from the registration sensor **135**. This is to obviate a jam stated earlier. If the answer of the step **S41** is NO, meaning that the trailing edge of the preceding sheet **P0** has not moved away form the registration sensor **135**, the registration clutch **104** is turned on while the sheet feed motor **107** is driven in the reverse direction (steps S42 and S**43**).

After the step **S43**, whether or not the registration sensor **135** has turned on, i.e., whether or not the leading edge of the sheet P being conveyed has reached the registration sensor **135** is determined (step S44). If the answer of the step S44 is YES, meaning that the leading edge of the sheet P being conveyed has moved away from the sensor **135**, the sheet feed motor **107** is rotated in the reverse direction by a designated number of steps so as to rotate the intermediate rollers **118***a* and **118***b* by a preselected amount. As a result, the leading edge of the sheet P abuts against the portion just upstream of the nip between the registration rollers **106***a* and **106***b* and forms an adequate loop. Then, the reverse rotation of the motor **107** is stopped (steps **S44**–**S46**).

In this manner, to cause the leading edge of the sheet P to form an adequate loop, the sheet feed motor **107** is driven by a designated number of steps in the reverse direction to rotate the intermediate rollers **118***a* and **118***b* by a preselected amount. In the illustrative embodiment, the sheet P is fed by an amount which is the sum of the distance of 19 mm between the upstream end of the nip between the registration rollers **106***a* and **106***b* and the registration sensor **135** on the vertical transport path RZ and 6 mm, i.e., 25 mm in total. The bank sheet feed controller **148** translates the above amount of feed into the number of steps and then controls the sheet feed motor **107**. As a result, the motor **107** causes the intermediate rollers **118***a* and **118***b* to feed the sheet P such that the sheet P forms the preselected loop.

Subsequently, the registration motor **101** is driven forward by several steps until the registration rollers **106***a* and **106***b* nip the leading edge of the sheet P. While the rollers **106***a* and **106***b* are nipping the leading edge of the sheet P, the intermediate clutch **117** is uncoupled (steps S47 and S48).

The press drum **20** is caused to rotate counterclockwise. When the press drum **20** reaches an angular position θ' of 104°, the interrupter **71** interrupts the optical path of the bank sheet feed start sensor **66**. The sensor **66** therefore sends an ON signal to the printer sheet feed controller **88**. In response, the sheet feed controller **88** informs the bank sheet feed controller **148** of the turn-on of the sensor **66** (θ' of 104°) by serial communication (steps S49 and S**50**). This is followed by a delay Dd which prevents the leading edge of the sheet P being conveyed from catching up with the trailing edge of the preceding sheet P (step S51). Subsequently, the registration motor **101** is rotated by a designated number of steps to feed the leading edge of the sheet P toward the intermediate rollers **55***a* and **55***b* and registration rollers **33***a* and **33***b*. After the motor **101** has been deenergized, the registration clutch **104** is uncoupled (see steps S52–S55). This is followed by a routine for managing the condition of sheet feed.

The delay Dd intervenes between the time when the sheet feed start sensor **66** turns on and the time when the registration motor **101** actually starts rotating. The delay Dd defines the operation timing of the motor **101** by using the ON signal of the sensor **66** appearing at the angular position θ' of 104° of the press drum **20** as a trigger.

Assume that the tray **143** of the upper sheet feeding section **201** and its sheet size are selected and set (YES, step

S30). Then, the upper up-down motor **141** raises the tray **143** until the upper limit sensor **137** senses the top sheet of the tray **143** (step S56).

When the press drum **20** is rotated to the angular position θ' of 0°, the interrupter **70** interrupts the optical path of the sheet feed start sensor **66** as in the step S33 (YES, step S57). The resulting ON signal output from the sensor **66** is sent to the printer sheet feed controller **88**. In response, the controller **88** informs the bank sheet feed controller **148** of the turn-on of the sensor **66** by serial communication (step S58). Subsequently, whether or not the trailing edge of the preceding sheet P has moved away from the registration sensor **135** is determined (step S59). This is to obviate the previously stated occurrence. If the answer of the step S59 is NO, meaning that the trailing edge of the preceding sheet P has moved away from the sensor **135**, the sheet feed motor **107** is driven forward to cause the sheet feeding means **29-1** to start picking up the sheet P in FIG. **15** (step S60). More specifically, the separation roller **32** and pickup roller **30** of the sheet feeding means **29-1** are rotated clockwise, as viewed in FIG. **16**, by way of the operation of the drive mechanism **125**B. As a result, only the top sheet P is paid out in the direction **X1**.

Because the set print speed is lower than the standard print speed the third, second or first speed or the trial print speed lower than the standard speed, the sheet feed controller **148** causes the sheet feed motor **107** to rotate in the forward direction. Therefore, the separation roller **32** and pickup roller of the sheet feeding means **29-1** convey the sheet P at a speed corresponding to the standard or third print speed (90 rpm), i.e., at a peripheral speed of 847.8 mm/sec.

Subsequently, whether or not the registration sensor **135** has turned on, i.e., whether or not the leading edge of the sheet P being paid out has reached the registration sensor **135** is determined (step S61). If the answer of the step S61 is YES, meaning that the above leading edge has reached the sensor **135**, the sheet feed motor **107** is driven forward by a designated number of steps to rotate the separation roller **32** and pickup roller **30** by a preselected amount. As a result, the leading edge of the sheet P abuts against the portion just upstream of the nip between the registration rollers **106***a* and **106***b* and forms an adequate loop. Thereafter, the sheet feed motor **107** is deenergized (steps S62 and S63).

In the illustrative embodiment, to cause the leading edge of the sheet P to form an adequate loop, the above rotation of the separation roller **32** and pickup roller **30** conveys the sheet P by the same amount as the rotation of the separation roller **32** and pickup roller **30** of the lower sheet feeding means **29-2**. To control the sheet feed motor **107** in accordance with the above amount of sheet feed, the sheet feed controller **148** translates the amount of sheet feed into a number of steps and delivers the number of steps to the motor **107**. Consequently, the motor **107** causes the separation roller **32** and pickup roller **30** of the sheet feeding mean **29-1** to convey the sheet P by the amount for forming an adequate loop.

In the case of sheet feed from the bank sheet feeding section **200**, the bank sheet feed controller **148** controls the sheet feed motor **107** independently of the driveline assigned to the ink drum **1** in such a manner as to effect the unique loop adjustment. Specifically, the leading edge of the sheet P abuts against the portion just upstream of the nip between the registration rollers **106***a* and **106***b* and forms the preselected loop PA. This successfully obviates a short loop at low print speeds without regard to the print speed varying every minute due to the aging of a belt included in the ink drum driveline and the backlashes of gears. Further, the sheet P is prevented from skewing or from being not fed due to the rotation of the registration rollers **106***a* and **106***b*, and can therefor stably form the expected loop.

Subsequently, the registration motor **101** is driven forward by several steps until the registration rollers **106***a* and **106***b* nip the leading edge of the sheet P (step S64). This is followed by the step S49 stated earlier.

Assume that a sheet P is to be fed from the tray **145** of the lower sheet feeding section **202**, and that the operator selects and sets the fourth print speed on the print speed key **96**. Then, the main motor **150** drives the ink drum **1** and press drum **20** at a speed matching with the set fourth print speed. Because the set print speed is higher than the standard speed, the bank sheet feed controller **148** drives the sheet feed motor **107** such that the intermediate rollers **118***a* and **118***b* convey the sheet P at a speed corresponding to the fourth print speed (105 rpm), i.e., a peripheral speed of 989.1 mm/sec. Again, the sheet P is subjected to loop adjustment as during trial printing.

Assume that the operator selects the fifth or highest print speed on the print speed key **96**. Then, the main motor **150** rotates the ink drum **1** and press drum **20** in such a manner as to implement a print speed corresponding to the set fifth speed. Because the set print speed is higher than the standard speed, the bank sheet feed controller **148** drives the sheet feed motor **107** in the reverse direction such that the intermediate rollers **118***a* and **118***b* convey the sheet P at a speed corresponding to the set fifth print speed (120 rpm), i.e., a peripheral speed of 1,130.4 mm/sec. Again, the sheet P is fed by an amount subjected to the previously stated loop adjustment.

On the other hand, assume that a sheet P is to be fed from the tray **143** of the upper sheet feeding section **201**, and that the operator selects the fourth print speed higher than the standard speed. Then, the sheet feed controller **148** drives the sheet feed motor **107** forward such that the separation roller **32** and pickup roller **30** of the upper sheet feeding means **29-1** convey the sheet at a speed corresponding to the set fourth print speed (105 rpm), i.e., a peripheral speed of 989.1 mm/sec. Again, the sheet P is fed by an amount subjected to the loop control.

Assume that the operator selects the fifth or highest print speed. Then, because the set print speed is higher than the standard speed, the bank sheet feed controller **148** drives the sheet feed motor **107** in the forward direction such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29-1** convey the sheet P at a speed corresponding to the set fifth print speed (120 rpm), i.e., a peripheral speed of 1,130.4 mm/sec. Again, the sheet P is fed by an amount subjected to the previously stated loop adjustment.

The bank sheet feed controller **148** controls the sheet feed motor **107** independently of the driveline assigned to the ink drum **1** in such a manner as to effect the unique loop adjustment, as stated above. Specifically, the leading edge of the sheet P abuts against the portion just upstream of the nip between the registration rollers **106***a* and **106***b* and forms the preselected loop PA. This successfully obviates a short loop at low print speeds without regard to the print speed varying every moment due to the aging of a belt included in the ink drum driveline and the backlashes of gears. Further, the sheet P is prevented from skewing or from being not fed due to the rotation of the registration rollers **106***a* and **106***b*, and can therefore stably form the expected loop.

A step S5 and successive steps shown in FIG. **28** will be described with reference also made to FIGS. **23–27**. In

FIGS. **23**–**27**, the sheet P fed from the bank **200** is indicated by a phantom line. Steps S5–S7 are identical with the steps S49–S51 of FIG. **31** and will not be described specifically in order to avoid redundancy. In a step S**8**, the registration motor **101** is driven to rotate the registration rollers **106***a* and **106***b*. When the intermediate sensor **54** senses the leading edge of the sheet P, the sheet feed motor **74** is driven in the reverse direction to rotate the intermediate rollers **55***a* and **55***b* (steps S**9** and S**10**).

As shown in FIG. **20**, a preselected delay Df occurs between the time when the registration motor **101** is driven and the time when the sheet feed motor **74** is driven in the reverse direction. The delay Df serves to reduce the duration of drive of the sheet feed motor **74** as far as possible. Specifically, as FIG. **20** suggests, the illustrative embodiment drives the sheet feed motor **74** over a relatively long period of time. For example, heat generated by a driver assigned to the motor **74** would result in, e.g., the loss of synchronism of the motor **74**. It is to be noted that the above delay Df is not necessary if the duration of drive of the motor **74** is short.

The intermediate sensor **53** senses the leading edge of the sheet P being conveyed by the intermediate rollers **55***a* and **55***b*. The rollers **55***a* and **55***b* further convey the sheet P to the downstream side of the vertical transport path RZ. When the leading edge sensor **51** senses the leading edge of the sheet P (YES, step S**11**), the sensor **51** sends an ON signal to the printer sheet feed controller **88**.

In the above condition, assume the set print speed is any one of the third, second, first and trail print speeds lower than the standard speed. Then, the sheet feed controller **88** drives the sheet feed motor **74** in the reverse direction such that the intermediate rollers **55***a* and **55***b* convey the sheet P at a speed corresponding to the standard or third speed (90 rpm), i.e., a peripheral speed of 847.8 mm/sec. If the set print speed is the fourth speed higher than the standard speed, the controller **88** drives the motor **74** in the reverse direction to cause the rollers **55***a* and **55***b* to convey the sheet P at a speed corresponding to the fourth speed (105 rpm), i.e., a peripheral speed of 989.1 mm/sec. Further, if the set print speed is the fifth or highest speed, the controller **88** drives the motor **74** in the reverse direction such that the rollers **55***a* and **55***b* convey the sheet at a speed corresponding to the fifth speed (120 rpm), i.e., a peripheral speed of 1,130.4 mm/sec.

As shown in FIG. **6**, the above intermediate rollers **55***a* and **55***b* feed the sheet P by a preselected amount such that the leading edge of the sheet P abuts against the portion just upstream of the nip between the registration rollers **33** and **33***b* and forms the preselected loop PA. Specifically, the controller **88** sends particular drive pulses to the sheet feed motor **74** via the driver, depending on whether the sheets P is fed from the upper sheet feeding section **201** or whether it is fed from the lower feeding section **202** and on the sheet size. As a result, the rollers **55***a* and **55***b* convey the sheet P by a preselected amount (step S**12**).

The preselected loop PA is confined in an experimentally determined range capable of preventing the sheet P from skewing or being not fed due to the rotation of the registration rollers **33** and **33***b*, and capable of providing the loop PA with a size adequate enough to reduce noise. To implement such a loop PA, the controller **88** drives the sheet feed motor **74** in the reverse direction such that the sheet P paid out from the upper sheet feeding section **201** is conveyed by a greater amount than the sheet P paid out from the lower sheet feeding section **202**, taking account of a sheet conveyance load, among others.

As stated above, the printer sheet feed controller **88** controls the sheet feed motor **74** independently of the driveline assigned to the ink drum **1** in such a manner to effect the unique conveyance speed adjustment and loop adjustment. This successfully obviates a short loop at low print speeds without regard to the print speed varying every moment due to the aging of a belt included in the ink drum driveline and the backlashes of gears. Further, the sheet P is prevented from skewing or from being not fed due to the rotation of the registration rollers **33***a* and **33***b*, and can therefor stably form the expected loop. Further, noise can be reduced at the standard print speed. In addition, a short loop is obviated with consideration given to noise reduction at high print speeds.

Subsequently, as shown in FIGS. **20** and **21A**, when the press drum **20** is further rotated counterclockwise to an angular position θ' of 307°, the interrupter **69** interrupts the optical path of the sheet feed start sensor **65**. The sensor **65** therefore turns on and sends an ON signal to the printer sheet feed controller **88**. The controller **88** drives the registration motor **58** on the elapse of the delay Db since the receipt of the ON signal (steps S**13** and S**14**). The motor **58** rotates the registration roller **33***b* counterclockwise and causes it to start conveying the leading edge of the sheet P toward the sheet clamper **21** of the press drum **20** (step S**15**).

After the leading edge of the sheet P has moved away from the nip between the registration rollers **33***a* and **33***b*, it is subjected to conveyance and printing at a print speed and a conveyance speed matching with a set print speed by unique operations which will be described hereinafter.

Assume that the above sheet P is of size A**4** or greater. Then, the sheet feed motor **74** is driven in the reverse direction for a short period of time such that the intermediate rollers **55***a* and **55***b* perform unique assist or auxiliary rotation (step Sl**6**). This assist rotation successfully reduces a load acting on the registration rollers **33***a* and **33***b* and prevents the sheet P from slipping at the nip between the rollers **33***a* and **33***b*.

More specifically, the sheet feed motor **74** is driven to vary the conveying speed of the intermediate rollers **55***a* and **55***b* in order to maintain the loop PA of the sheet just upstream of the nip between the registration rollers **33***a* and **33***b* adequate. This is done in accordance with the position of the sheet feeding section, sheet size and print speed while the rollers **33***a* and **33***b* are conveying the sheet P. The above conveying sheet of the rollers **55***a* and **55***b* is stored in the ROM beforehand in the form of a control table. With the control table, it is possible to prevent the loop PA formed at the upstream side of the rollers **33***a* and **33***b* in the direction Z from disappearing or growing excessively while the rollers **33***a* and **33***b* are conveying the sheet S toward the sheet clamper **21**. It was experimentally found that when the sheet size was B5 or smaller, the assist rotation of the rollers **55***a* and **55***b* was not necessary.

The above control executed by the printer sheet feed controller **88** over the conveying speed of the intermediate rollers **55***a* and **55***b* is far more advantageous over the conventional sheet conveyance relying only on the registration rollers **33***a* and **33***b*. The conventional conveyance is apt to dislocate an image on the sheet S due to scattering in the amount of conveyance, to limit the kind of sheets to convey, or to fail to follow high speed conveyance. For high speed conveyance, the conveying speed of the registration rollers **3***a* and **33***b* would have to be lowered.

Further, the sheet feed motor **74** implemented by a stepping motor exhibits sharp response when caused to rotate. In addition, the above control reduces noise ascribable to the sudden disappearance of the loop PA and a load to act on the registration rollers **33***a* and **33***b* and ascribable to the same.

In FIG. **20**, the assist rotation of the intermediate rollers **55***a* and **55***b* is indicated by a phantom line. As shown, on the elapse of the delay De since the start of rotation of the registration motor **58**, i.e., the registration rollers **33***a* and **33***b*, the sheet feed motor **74** causes the rollers **55***a* and **55***b* to perform the assist rotation. That is, the delay De intervenes between the time when the registration motor **58** starts its rotation and the time when the rollers **55***a* and **55***b* start their assist rotation. The delay De is therefore set for each of different conveying speeds (peripheral speeds or linear velocities) in order to define the operation timing of the sheet feed motor **74**, i.e., the operation timing of the rollers **55***a* and **55***b* (step S17).

As stated above, in the step S18, the intermediate rollers **55***a* and **55***b* start their assist rotation. Specifically, the printer sheet feed controller **88** so controls the sheet feed motor **74** as to vary the conveying speed of the rollers **55***a* and **55***b* in accordance with the position of the sheet feeding section selected as well as the sheet size and print speed. Further, in the illustrative embodiment, the registration rollers **106***a* and **106***b* disposed in the bank sheet feeding section **200** convey the leading edge of the sheet P toward the registration rollers **33***a* and **33***b*. These registration rollers **106***a* and **106***b* cause a minimum of skew, lateral misregistration and crease to occur during sheet feed form the sheet feeding section **200**. Moreover, the sheet conveyance control described above allows the sheets P to be fed toward the registration rollers **33***a* and **33***b* at a constant timing and therefore corrects the variation of the amount of sheet feed which may occur between the sheet feeding section **200** and the registration rollers **33***a* and **33***b* due to, e.g., the slip of the sheet P.

Assume the condition shown in FIG. **21**C in which the registration rollers **33***a* and **33***b* convey the sheet P from the position where its leading edge abuts against the portion just upstream of the nip between the registration rollers **33***a* and **33***b* to the downstream side of the transport path RX by Xb mm (19 mm in the illustrative embodiment). Then, he registration sensor **52** turns on with the result that slip correction is effected in the same manner as during sheet feed from the auxiliary sheet feeding section **28**.

After the above slip correction, the printer sheet feed controller **88** receiving the output pulses of the encoder sensor **61** controls the registration motor **58** such that the leading edge of the sheet P meets the sheet clamper **21** brought to its clamp position (FBC, FIG. **21**A). In this case, the printer sheet feed controller **88** executes control different from the control described in relation to the auxiliary sheet feeding section **28**, as follows. The controller **88** executes feedback control meant for the sheet feed motor **74** in accordance with the output pulses of the encoder sensor **61** in addition to the feedback control meant for the registration motor **58**. By controlling the sheet feed motor **74**, it is possible to prevent the loop PA of the sheet P from becoming excessively great or disappearing on the basis of the rotation of the intermediate rollers **55***a* and **55***b*.

As stated above, the amount in which the sheet P is conveyed by the registration motor **58** and sheet feed motor **74** in response to a single pulse and the amount in which the circumference of the press drum **20** is moved in response to a single pulse width of the encoder **60** are identical. For FBC, the printer sheet feed controller **88** counts a period of time necessary for a single pulse width of the encoder **60** with the timer thereof and decelerates the registration motors **58** and **74** if the above period of time increases due to, e.g., a change in the load acting on the press drum **20**. Conversely, when the period of time necessary for a single pulse of the encoder **60** decreases, the controller **88** accelerates the motors **58** and **74**.

Stated another way, the controller **88** constantly detects the advance or the delay of the leading edge of the sheet P being conveyed by the registration rollers **33***a* and **33***b* and corrects both of the conveying speed of the rollers **33***a* and **33***b* and the conveying speed of the intermediate rollers **55***a* and **55***b*. The controller **88** constantly traces the irregular rotation, i.e., irregular peripheral speed of the press drum **20** in terms of changes in the pulses output from the encoder **61**. The controller **88** variably controls the rotation speeds of the registration motor **58** and sheet feed motor **74** in accordance with the variation of pulses output from the encoder **61** (FBC using the encoder **61**). At this instant, the controller **88** determines the angular position of the press drum **20** in terms of the number of pulses sensed by the encoder sensor **61** and determines the peripheral speed of the drum **20** in terms of the period of time t also sensed by the encoder sensor **61**. As shown in FIG. **22**, the controller **88** further varies the drive pulse width (t1–t4) for the registration motor **58** in order to control the motors **58** and **74** by feedback control. This reduces misregistration and thereby increases registration accuracy.

Under the above encoder feedback control executed by the printer sheet feed controller **88**, the upper registration roller **33***a* is rotated clockwise by the lower registration roller **33***b* rotating clockwise via the sheet P. This, coupled with the fact that the intermediate roller **55***b* is rotated clockwise via the sheet P, causes the loop PA of the sheet P to disappear little by little. When the intermediate sensor **53** turns off, i.e., when the trailing edge of the sheet P moves away from the sensor **53**, the sheet feed motor **74** is caused to stop rotating in the reverse direction, causing the intermediate rollers **55***a* and **55***b* to stop their assist rotation. When the ink drum **1** reaches an angular position θ' of 75° (the press drum **20** also reaches the same angular position), the registration motor **58** is deenergized with the result that the registration rollers **33***a* and **33***b* stop rotating. This is followed by the routine for managing the sheet feed condition (steps S22–S25).

In the step S16, if the sheet size is B**5** or smaller which does not need the assist rotation of the intermediate rollers **55***a* and **55***b*, then the operation is transferred to the step S23 in order to execute the steps described above. The operation to follow is identical with the sheet feeding and printing procedure relating to the auxiliary sheet feeding section **28** and will not be described in order to avoid redundancy.

The illustrative embodiment has the following various advantages in addition to the above advantages.

In a conventional sheet feeding device, a main motor assigned to the ink drum **1** and press drum **20** drives the separation roller **32** and pickup roller **30** via a sector gear system including belts and clutches. In this condition, the peripheral speeds of the separation rollers **32** and pickup rollers **30** of the sheet feeding means **29**, **29-1** and **29-2** are dependent on the print speed slightly varying every moment. Therefore, the amount of the loop PA varies in accordance with the varying print speed. This brings about the skew and feed failure of a sheet ascribable to a short loop or noise ascribable to an excessive loop.

By contrast, in the illustrative embodiment, the interrupter **68** and sheet feed sensor **65** are mounted on the press drum

20 for determining the time when the leading edge of the sheet P should be fed toward the registration rollers **33***a* and **33***b*. The amount of loop is controlled on the basis of the output of the leading edge sensor **51** while the sheet feed motor **74** implemented by a stepping motor and independent of the main motor **150** drives the separation roller **32**, pickup roller **30** and intermediate rollers **55***a* and **55***b*. With this configuration, the illustrative embodiment is capable of stably adjusting the amount of the loop and thereby reducing skew, feed failure and noise.

Generally, the coefficient of friction of the sheet P contacting the registration rollers **33***a* and **33***b* depends on the quality and thickness thereof. Even when sheets of the same quality and thickness are used, the slip of the sheet P increases due to the variation of conveying conditions (e.g. coefficient of friction between the sheet P and the registration rollers **33***a* and **33***b* or shape of the sheet P) ascribable to the varying environmental conditions including temperature and humidity. Also, the slip increases when the registration rollers **33***a* and **33***b* wear or is contaminated by, e.g., paper dust or deteriorated due to aging. The slip is greatest when the leading edge of the sheet P begins to be conveyed by the registration rollers **33***a* and **33***b*. In the illustrative embodiment, the registration sensor **52** is capable of determining the position of the leading edge of the sheet P. The interrupter **69** and sheet feed start sensor **65** are mounted on the press drum **20** for determining the time when the leading edge of the sheet P should be fed toward the sheet clamper **21**. The printer sheet feed controller **88** corrects the slip of the sheet P on the basis of the output of the registration sensor **52** while controlling the registration motor **58** by FBC using the pulse encoder (encoder **60** and encoder sensor **61**). The sheet clamper **21** can therefore clamp the sheet P surely and stably, preventing the sheet P from rolling up more positively. In addition, the sheet P can be fed toward the sheet clamper **21** with enhanced stability and reliability, so that accurate registration is further enhanced.

The driveline assigned to the registration rollers **33***a* and **33***b* is independent of the driveline including the main motor **150** and assigned to the ink drum **1** and press drum **20**. This reduces the load to act on the driveline including the main motor **150** and therefore power required of the main motor **150**. Therefore, the illustrative embodiment reduces the cost of the main motor **150**.

Because the registration drive means is implemented by the registration motor **58** which is a stepping motor, mechanical parts for braking the registration rollers **33***a* and **33***b* while regulating the direction of rotation thereof are not necessary. This not only reduces the cost of the sheet feeding device, but simplifies the programs of the control unit. In addition, calculations are sped up to provide FBC with an accurate following ability.

The sheet feed drive means and sheet conveyance drive means are implemented by the sheet feed motor **74** which is also a stepping motor **74**. Such means therefore exhibit sharp response at the time of drive and obviate the need for mechanical parts for regulating the direction of the separation roller **32**, thereby reducing the cost of the device. In addition, the driveline assigned to the separation roller **32** and pickup roller **30** is independent of the driveline including the main motor **150** and assigned to the ink drum **1** and press drum **20**. This reduces the load to act on the driveline including the main motor **150** and therefore further reduces power required of the main motor **150**. Therefore, the illustrative embodiment further reduces the cost of the main motor **150**.

The bank sheet conveyance drive means is implemented by the bank sheet feed motor **107** which is also a stepping motor. Such means therefore exhibit sharp response at the time of drive and obviate the need for mechanical parts for regulating the directions of rotation of the separation rollers **32** and pickup rollers **30** of the sheet feeding sections **29-1** and **29-2**, thereby reducing the cost of the device. In addition, the driveline assigned to the separation rollers **32** and pickup rollers **30** is independent of the driveline including the main motor **150** and assigned to the ink drum **1** and press drum **20**. This reduces the load to act on the driveline including the main motor **150** and therefore further reduces power required of the main motor **150**.

Therefore, the illustrative embodiment further reduces the cost of the main motor **150**.

The bank registration drive means is implemented by the bank registration roller **101** which is also a stepping motor. Such means therefore exhibits sharp response at the time of drive. Again, the driveline is independent of the driveline including the main motor **150**. This reduces the load to act on the driveline including the main motor **150** and therefore further reduces power required of the main motor **150**.

A second embodiment of the present invention will be described hereinafter. This embodiment differs from the above embodiment mainly in that a printer sheet feed controller **88**A and a bank sheet feed controller **148**A are substituted for the printer sheet feed controller **88** and bank sheet feed controller **148**, respectively.

The printer sheet feed controller **88**A differs from the printer sheet feed controller **88** in the following respect. Assume that a sheet is fed from the auxiliary sheet feeding section **28**, and that the operator inputs the fourth or fifth print speed higher than the standard speed on the DOWN key **96***a* or UP key **96***b*. Then, in response to a signal representative of the set print speed, the printer sheet feed controller **88**A drives the sheet feed motor **74** forward such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29** convey the sheet at a speed corresponding to the fifth or highest print speed, i.e., a peripheral speed of 1,130.4 mm/sec. When the set print speed is the third, second, first or trial print speed lower than the standard speed, the sheet feed motor **74** operates in the same manner as in the first embodiment.

Assume that a sheet is fed from the bank sheet feeding section **200**, and that the operator inputs the fourth or fifth print speed higher than the standard speed on the DOWN key **96***a* or UP key **96***b*. Then, in response to a signal representative of the set print speed, the printer sheet feed controller **88**A drives the sheet feed motor **74** in the reverse direction such that the intermediate rollers **55***a* and **55***b* convey the sheet at a speed corresponding to the fifth or highest print speed, i.e., a peripheral speed of 1,130.4 mm/sec. When the set print speed is the third, second, first or trial print speed lower than the standard speed, the sheet feed motor **74** operates in the same manner as in the first embodiment.

As for the bank sheet feed controller **148**A, assume that a sheet is fed from the upper sheet feeding section **201**, and that the operator inputs the fourth or fifth print speed higher than the standard speed on the DOWN key **96***a* or UP key **96***b*. Then, in response to a signal representative of the set print speed and transferred from the printer sheet feed controller **88**A, the bank sheet feed controller **148**A drives the bank sheet feed motor **107** forward such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29-1** convey the sheet at the highest speed corresponding to the fifth or highest print speed, i.e., a peripheral speed of 1,130.4 mm/sec. When the set print speed is the third, second, first or trial print speed lower than the standard speed, the sheet feed motor **74** operates in the same manner as in the first embodiment.

Assume that a sheet is fed from the lower sheet feeding section **202** of the bank sheet feeding section **200**, and that the set print speed input on the DOWN key **96***a* or the UP key **96***b* is the fourth or fifth print speed higher than the standard speed. Then, the bank sheet feed controller **148**A drives the bank sheet feed motor **107** in the reverse direction such that the intermediate rollers **118***a* and **118***b* convey the sheet at a speed corresponding to the fifth print speed, i.e., a peripheral speed of 1,130.4 mm/sec.

The operation of the second embodiment will not be described in detail because it is analogous to the operation of the first embodiment.

A third embodiment of the present invention includes a printer sheet feed controller **88**B and a bank sheet feed controller **148**B in placed of the printer sheet feed controller **88** and bank sheet feed controller **148** of the first embodiment.

Assume that a sheet is fed from the auxiliary sheet feeding section **28**. Then, in response to a signal representative of a set print speed input on the DOWN key **96***a* or the UP key **96***b*, the printer sheet feed controller **88**B drives, without regard to the set print speed, the sheet feed motor **74** forward such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29** convey the sheet at a speed corresponding to the fifth or highest print speed, i.e., a peripheral speed of 1,130.4 mm/sec.

Assume that a sheet is fed from the bank sheet feeding section **200**. Then, in response to a signal representative of the set print speed and input on the DOWN key **96***a* or the UP key **96***b*, the printer sheet feed controller **88**B drives, without regard to the set print speed, the sheet feed motor **74** in the reverse direction such that the intermediate rollers **55***a* and **55***b* convey the sheet at a speed corresponding to the fifth or highest print speed, i.e., a peripheral speed of 1,130.4 mm/sec.

As for the bank sheet feed controller **148**B, assume that a sheet is fed from the upper sheet feeding section **201**. Then, in response to a signal representative of the set print speed input on the DOWN key **96***a* or the UP key **96***b* and transferred from the printer sheet feed controller **88**B, the bank sheet feed controller **148**B drives the bank sheet feed motor **107** forward such that the separation roller **32** and pickup roller **30** of the sheet feeding means **29-1** convey the sheet at a constant speed corresponding to the fifth or highest print speed, i.e., a peripheral speed of 1,130.4 mm/sec. When the set print speed is the third, second, first or trial print speed lower than the standard speed, the sheet feed motor **74** operates in the same manner as in the first embodiment.

Assume that a sheet is fed from the lower sheet feeding section **202** of the bank sheet feeding section **200**. Then, in response to a signal representative of the set print speed input on the DOWN key **96***a* or the UP key **96***b* and transferred from the printer sheet feed controller **88**B, the bank sheet feed controller **148**B drives the bank sheet feed motor **107** in the reverse direction such that the intermediate rollers **118***a* and **118***b* convey the sheet at a constant speed corresponding to the fifth print speed, i.e., a peripheral speed of 1,130.4 mm/sec.

The operation of the third embodiment will not be described in detail because it is also analogous to the operation of the first embodiment.

A first modification of the first embodiment will be described with reference to FIG. **19**. As shown in FIGS. **17** and **19**, the modification differs from the first embodiment of FIGS. **1–31** in that it uses the kind-of-sheet key 190 for inputting the kind of sheets to be used and includes a printer sheet feed controller **88**C in place of the printer sheet feed controller **88**.

Usually, a stencil printer, among others, is operated with various kinds of sheets including low quality sheets to high quality sheets, envelopes, and thin sheets to thick sheets. The slip on the registration rollers **33***a* and **33***b* noticeably differs from one kind of sheets to another kind of sheets. Therefore, should the registration motor **65** be simply driven on the basis of an ON signal output from the sheet feed start sensor **65**, the sheet P could not be stably conveyed. In light of this, the modification varies the timing for driving the registration motor **58** in accordance with the kind of sheets. For this purpose, the modification causes the printer sheet feed controller **88**C to additionally play the role of registration drive start varying means for varying the drive start point of the delay Db, FIG. 21A.

Specifically, when the operator inputs the kind of sheets on the kind-of-sheet key **190**, the printer sheet feed controller **88**C varies the drive start point of the delay Db by using the ON output of the sheet feed start sensor **65** as a trigger. As a result, the timing for starting driving the registration motor **58** is varied in accordance with the kind of sheets. For example, as for thin sheets and thick sheets, the controller **88**C sequentially reduces the delay Db from the thin sheets to the thick sheets. As for low quality sheets and high quality sheets as well as envelopes, optimal delay DB ranges may also be determined by, e.g., experiments.

The above control is also applicable to the registration motor **101** assigned to the bank sheet feeding section **200**. Specifically, a bank sheet feed controller **148**C replacing the bank sheet feed controller **148** may vary the drive start point of the delay Db, i.e., the start timing of the bank registration motor **101** by using the ON output of the bank sheet feed start sensor **66**.

A second modification of the first embodiment will be described with reference to FIG. **19**. As shown, this modification differs from the first modification mainly in that it includes a kind-of-sheet sensor **195**, a bank upper kind-of-sheet sensor **195-1** and a bank lower kind-of-sheet sensor **195-2** (collectively kind-of-sheet sensing means) in place of the kind-of-sheet key **190**, and a printer sheet feed controller **88**D in place of the printer sheet feed controller **88**C.

The kind-of-sheet sensors **195**, **195-1** and **195-2** each may be of the type optically sensing the intensity of transmitted light representative of the thickness of the sheet P or of the type mechanically measuring a sheet thickness with an electrical sensor by increasing a gap between rollers. To vary the drive start point of the delay Db, the printer sheet feed controller **88**D additionally plays the role of registration drive start varying means for varying the drive start point of the delay Db, i.e., the start timing of the registration motor **58**. The control of the second modification will not be described in because it is analogous to the control of the first modification.

The above control is also applicable to the registration motor **101** assigned to the bank sheet feeding section **200**. Specifically, a bank sheet feed controller **148**D replacing the bank sheet feed controller **148**C may vary the drive start point of the delay Db, i.e., the start timing of the bank registration motor **101** by using the ON output of the bank sheet feed start sensor **66**.

In the first and second modifications, the delays Db and Dd may be set on the basis of time or on the basis of the rotation of the press drum **20** sensed by the pulse encoder including the encoder sensor **61**. Because the printer sheet feed controller **88**C or **88**D and bank sheet feed controller **148**C or **148**D each are implemented by a microcomputer, the delays Db and Dd may be set and counted by the timer included in the microcomputer and variably controlled.

A third modification of the first embodiment will be described with reference to FIGS. **1**–**31**. The third modification does not include the interrupters **68**–**71**, sheet feed sensors **65** and **66**, incremental encoder **60**, and encoder sensor **61**. As shown in FIG. **32**, the third embodiment includes an absolute pulse encoder mounted on the press drum **20** and capable of sensing the variation of the rotation speed and the position of the press drum **20**, i.e., an absolute amount of rotation.

Specifically, the absolute pulse encoder includes a multichannel photoencoder **220** mounted on the end wall **20***b* of the press drum **20** and formed with a number of concentric radial slits in its peripheral portion. A plurality of encoder sensors **221** are mounted on the arm **25***b*, and each sandwiches the peripheral portion of the photoencoder **220**. The control available with the third modification is identical with the control of the first embodiment except that a single absolute encoder replaces the interrupters **69**–**71**, sensors **65** and **66**, incremental encoder **60**, and encoder sensor **61**.

Again, the delay Da intervenes between the time when the encoder sensor **221** outputs an ON pulse representative of the preselected angular position of the press drum **20** and the time when the sheet feed motor **74** begins to be driven. The other delays Db, Dc, Dd, De and Df are also set in the same manner as in the first embodiment.

The third embodiment is capable of reducing the number of parts for control although the control may be expensive and sophisticated at the present stage of development, while achieving the same advantages as the first and second embodiments and first and second modifications.

Technical arrangements unique to the present invention may be summarized as follows.

(1) In a first technical arrangement, a stencil printer includes an ink drum for wrapping a master therearound, a press drum including clamping means for clamping the leading edge of a sheet fed thereto and having substantially the same outside diameter as the ink drum, and registering means for feeding the leading edge of the sheet toward the clamping means. The press drum is pressed against the ink drum relative to the ink drum at the time of printing. A pulse encoder is used to control a timing for feeding the leading edge of the sheet toward the clamping means and includes an encoder sensor responsive to the variation of at least the rotation speed of the press drum. Registration drive means drives the registering means. Leading edge sensing means is located on a transport path between the press drum and the registering means for sensing the leading edge of the sheet. Registration drive control means controls, based on a signal output from the leading edge sensing means, the registration drive means for compensating for a slip of the sheet on the registering means. Subsequently, the registration drive control means controls, in response to a pulse signal output form the encoder sensor, the registration drive means for feeding the leading edge of the sheet in synchronism with the rotation of the clamping means.

The pulse encoder is of the incremental type capable of sensing the variation of rotation speed to thereby determine a relative amount of rotation or of the absolute type capable of sensing the variation of rotation speed and a position to thereby determine an absolute amount of rotation. The pulse encoder included in the first arrangement senses at least the variation of rotation speed of the press drum and therefore includes both of the incremental type and absolute type pulse encoders. While the pulse encoder should preferably be implemented by a photoencoder from the stability and reliability standpoint, it may be implemented by, e.g., a magnetic encoder if stability and reliability are not of primary importance. The pulse encoder should preferably be mounted on the press roller or may be mounted on a main motor for driving the ink drum or on the ink drum.

In the first arrangement, a second technical arrangement is characterized in that the registration drive control means is implemented by a stepping motor and controls the registration drive means by varying the number of drive pulses to be fed thereto.

In the second arrangement, a third technical arrangement is characterized in that after compensating for the slip of the sheet, the registration drive control means controls the registration drive means by feedback control in accordance with the output pulse signal of the encoder sensor and by varying the pulse width.

In the second arrangement, a fourth technical arrangement is characterized in that a delay time is provided between the time when the encoder sensor starts outputting the pulse signal and the time when the registration drive means begins to be driven (drive start point). Registration drive start varying means varies the drive start point and therefore the delay time in accordance with the kind of sheets.

In the first, second or third arrangement, a fifth technical arrangement is characterized in that timing sensing means is mounted on the press drum for determining a timing for feeding the leading edge of the sheet toward the clamping means.

In the fifth arrangement, a sixth technical arrangement is characterized in that a delay time is provided between the time when the timing sensing means outputs an ON signal and the drive start point at which the registration drive means begins to be driven. Registration drive start varying means varies the drive start point and therefore the delay in accordance with the kind of sheets.

In the fourth or sixth arrangement, a seventh technical arrangement is characterized in that the registration drive control means bifunctions as the registration drive start varying means.

In the fourth and sixth arrangements, the delay times may be set on the basis of time or on the basis of the angular position of the press drum sensed by an encoder including an encoder sensor. When the registration drive control means is implemented by a microcomputer, the delay times may be set and counted by a timer included in the microcomputer. In this case, a CPU included in the microcomputer is capable of playing the role of the registration drive varying means by suitably reading delay times matching with the kind of sheets out of a ROM also included in the microcomputer or out of an external storage.

In the fourth, six or seventh arrangement, an eighth technical arrangement is characterized in that kind-of-sheet setting means allows the kind of sheets to be set.

In the fourth, sixth or seventh arrangement, a ninth technical arrangement is characterized in that kind-of-sheet sensing means senses the kind of sheets.

In any one of the first to ninth arrangements, a tenth technical arrangement is characterized in that sheet feed timing sensing means determines a timing for feeding the leading edge of the sheet toward the registering means.

In the tenth arrangement, an eleventh technical arrangement is characterized in that sheet feeding means feeds the leading edge of the sheet toward the registering means, and in that sheet feed drive control means controls the sheet feed drive means in responsive to a signal output from the sheet feed timing sensing means for thereby feeding the leading edge of the sheet toward the registering means.

In the eleventh arrangement, a twelfth technical arrangement is characterized in that the sheet feed drive means is implemented by a stepping motor.

In any one of the first to twelfth arrangements, a thirteenth technical arrangement is characterized in that the leading edge sensing means functions to detect a sheet jam.

In the first and other arrangements, the outside diameter of the press drum substantially the same as the outside diameter of the ink drum may include a design tolerance. To press the press drum against the ink drum relative to the ink drum, the press drum may be pressed against the ink drum, or the ink drum may be pressed against the press drum, or the ink drum and press drum may be pressed against each other. The press drum movable into and out of contact with the ink drum may be implemented by the press drum and moving means included in the illustrative embodiments.

For the control means, bank registration drive control means, bank sheet feed drive control means, registration drive control means and sheet feed drive control means, use may advantageously be made of a microcomputer or a microprocessor including a CPU, I/O ports, ROM, RAM and a timer.

For the bank registration timing sensing means, bank sheet feed timing sensing means, timing sensing means and sheet feed timing sensing means, use may advantageously be made of transmission type optical sensors (photointrrupter type photosensors) and interrupters from the stable and reliable operation standpoint. Of course, use may be made of reflection type optical sensors which are low cost and stably operable.

For the bank leading edge sensing means and leading edge sensing means, use may advantageously be made of reflection type optical sensors which are inexpensive and stably operable. To further enhance stability and reliability, the reflection type optical sensors may be replaced with transmission type optical sensors and interrupters. The optical sensors may, of course, be replaced with, e.g., microswitches having mechanical contacts if importance is not attached to stabilization or reliability.

The press drum movable into and out of contact with the ink drum refers also to a member movable substantially in synchronism with the press drum. Likewise, the ink drum movable into and out of contact with the press drum refers also to an apparatus body adjoining the ink drum.

The bank sheet feeding means and sheet feeding means each may be implemented by a pickup roller and a pair of separation rollers, by a loosening roller (pickup roller bifunctioning as a separation roller) taught in Japanese Patent Publication No. 5-32296, or by the pickup roller, separation roller and separation pad included in the illustrative embodiments.

In summary, it will be seen that the present invention provides a sheet feeding device for a printer having various unprecedented advantages, as enumerated below.

(1) Sheet conveyance drive means independent of a driveline assigned to an ink drum so drives sheet conveying means as to set up a constant sheet conveying speed without regard to a print speed input on print speed setting means. It is therefore possible to obviate a short loop and therefore skew and feed failure without regard to the print speed varying every moment due to the extension of a belt included in the ink drum driveline due to aging and the backlashes of gears.

(2) The sheet conveyance drive means drives, if the set print speed is higher than a standard print speed, the sheet conveying means in such a manner as to set up a sheet conveying speed matching with the set print speed or drives, if the set print speed is lower than the standard print speed, the sheet conveying means in such a manner as to set up a sheet conveying speed matching with the standard print speed. It is therefore possible to obviate a short loop and therefore skew and feed failure at low print speeds without regard to the print speed varying every moment due to the extension of the above belt and the backlashes of gears, while taking account of the noise of the entire printer ascribable to sheet conveyance. In addition, noise at speeds lower than the standard print speed predominant over the other speeds is reduced.

(3) The sheet conveyance drive means drives, if the set print speed is higher than a standard print speed, the sheet conveying means in such a manner as to set up a sheet conveying speed matching with the highest print speed or drives, if the set print speed is lower than the standard print speed, the sheet conveying means in such a manner as to set up a sheet conveying speed matching with the standard print speed. This is also successful to achieve the above advantage (2).

(4) In response to a signal output from leading edge sensing means positioned on a transport path between registering means and sheet conveying means, control means controls the sheet conveyance drive means such that the leading edge of a sheet abuts against the registering means and forms a preselected loop. Generally, a load acting on sheet conveyance depends on the transport path or the sheet size while the coefficient of friction of the sheet contacting the sheet conveying means depends on the quality and thickness thereof. Even when sheets of the same quality and thickness are used, the slip of the sheet increases due to the variation of conveying conditions (e.g. coefficient of friction between the sheet and the sheet conveying means or intermediate rollers or shape of the sheet) ascribable to the varying environmental conditions including temperature and humidity. Also, the slip increases when the sheet conveying means wears or is contaminated by, e.g., paper dust or deteriorated due to aging. The leading edge sensing means senses the position of the leading edge of the sheet when the slip increases in order to further stabilize the loop, thereby surely obviating skew and feed failure.

(5) The press drum having substantially the same outside diameter as the ink drum is pressed against the ink drum relative to the ink drum. This prevents the sheet from rolling up, reduces noise, and enhances accurate registration.

(6) Bank registering means for feeding the leading edge of the sheet toward registering means is included in a bank sheet feeding section independently of the registering means. This reduces the skew, lateral misregistration and crease of the sheet when the sheet is fed from the bank sheet feeding section. Further, the timing for feeding the sheet toward the registering means of the printer body is free from irregularity, so that a change in the amount of sheet conveyance ascribable to, e.g., the slip of the sheet occurring between the bank sheet feeding section and the registering means is compensated for. Moreover, bank sheet conveyance drive means independent of the driveline assigned to

the ink drum so drives bank sheet conveying means as to set up a constant sheet conveying speed without regard to the print speed input on the print speed setting means. It is therefore possible to obviate a short loop and therefore skew and feed failure without regard to the print speed varying every moment due to the extension of a belt included in the ink drum driveline due to aging and the backlashes of gears.

(7) When the set print speed is higher than the standard print speed, the bank sheet conveyance drive means drives the sheet conveying means in such a manner as to set up a conveying speed matching with the set print speed. When the set print speed is lower than the standard print speed, the bank sheet conveyance drive means drives the sheet conveying means in such a manner as to set up a conveying speed matching with the standard print speed. It is therefore possible to obviate a short loop and therefore skew and feed failure at low print speeds without regard to the print speed varying every moment due to the extension of the above belt and the backlashes of gears, while taking account of the noise of the entire printer ascribable to sheet conveyance. In addition, noise at speeds lower than the standard print speed predominant over the other speeds is reduced.

(8) When the set print speed is higher than the standard print speed, the bank sheet conveyance drive means drives the bank sheet feeding means in such a manner as to set up a conveying speed matching with the highest set print speed. When the set print speed is lower than the standard print speed, the bank sheet conveyance drive means drives the bank sheet feeding means in such a manner as to set up a conveying speed matching with the standard print speed. It is therefore possible to obviate a short loop and therefore skew and feed failure at low print speeds without regard to the print speed varying every moment due to the extension of the above belt and the back lashes of gears, while taking account of the noise of the entire printer ascribable to sheet conveyance. In addition, noise at speeds lower than the standard print speed predominant over the other speeds is reduced.

(9) In response to a signal output from bank leading edge sensing means positioned on a transport path between the bank registering means and the bank sheet conveying means, control means controls the bank sheet conveyance drive means such that the leading edge of a sheet abuts against the bank registering means and forms a preselected loop. Generally, a load acting on sheet conveyance depends on the transport path or the sheet size while the coefficient of friction of the sheet contacting the bank sheet conveying means depends on the quality and thickness thereof. Even when sheets of the same quality and thickness are used, the slip of the sheet increases due to the variation of conveying conditions (e.g. coefficient of friction between the sheet and the sheet conveying means or intermediate rollers or shape of the sheet) ascribable to the varying environmental conditions including temperature and humidity. Also, the slip increases when the bank sheet conveying means wears or is contaminated by, e.g., paper dust or deteriorated due to aging. The bank leading edge sensing means senses the position of the leading edge of the sheet when the slip increases in order to further stabilize the loop, thereby surely obviating skew and feed failure.

(10) Bank registration timing sensing means is mounted on the press drum for determining a timing for the bank registering means to feed the leading edge of the sheet toward the registering means. This enhances the stability and reliability of the timing for feeding the sheet toward the registering means.

(11) Bank registration drive control means is capable of controlling, in response to a signal output from the bank registration timing sensing means, the bank registration drive means in such a manner as to feed the leading edge of the sheet toward the registering means.

(12) Bank sheet feed timing sensing means is mounted on the press drum for determining a timing for the bank sheet feeding means to feed the leading edge of the sheet toward the bank registering means. This enhances the stability and reliability of the timing for feeding the sheet toward the bank registering means.

(13) Bank sheet feed drive control means is capable of controlling, in response to a signal output from the bank registration timing sensing means, the bank sheet feed drive means in such a manner as to feed the leading edge of the sheet toward the bank registering means.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof.

What is claimed is:

1. A sheet feeding device for a printer comprising an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, pressing means pressed against said ink drum relative to said ink drum with the intermediary of a sheet, registering means for feeding a leading edge of the sheet toward a print position between said ink drum and said pressing means, a bank sheet feeding section positioned below said print position, and sheet conveying means for conveying the sheet fed from said bank sheet feeding section toward said registering means, said sheet feeding device comprising:

print speed setting means for setting a print speed such that said ink drum rotates in accordance with a set print speed included in the plurality of print speeds; and

sheet conveyance drive means independent of a driveline assigned to said ink drum for driving said sheet conveying means;

said sheet conveyance drive means driving, when the set print speed is higher than a standard print speed, said sheet conveying means in such a manner as to set up a sheet conveying speed matching with said set print speed or driving, when said set print speed is lower than said standard print speed, said sheet conveying means in such a manner as to set up a sheet conveying speed matching with said standard print speed.

2. A sheet feeding device as claimed in claim **1**, further comprising:

leading edge sensing means positioned on a transport path between said registering means and said sheet conveying means for sensing the leading edge of the sheet; and

control means for controlling, in response to a signal output from said leading edge sensing means, said sheet conveyance drive means such that the leading edge of the sheet abuts against said registering means and forms a preselected loop.

3. A sheet feeding device as claimed in claim **1**, wherein said pressing means comprises a press drum having substantially a same outside diameter as said ink drum and pressed against said ink drum relative to said ink drum during printing.

4. A sheet feeding device for a printer comprising an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, pressing means pressed against said ink drum relative to said ink drum with the intermediary of a sheet, registering means for feeding a leading edge of the sheet toward a print position between said ink drum and said pressing means, a bank sheet feeding section positioned below said print position, and sheet conveying means for conveying the sheet fed from said bank sheet feeding section toward said registering means, said sheet feeding device comprising:

print speed setting means for setting a print speed such that said ink drum rotates in accordance with a set print speed included in the plurality of print speeds; and

sheet conveyance drive means independent of a driveline assigned to said ink drum for driving said sheet conveying means;

said sheet conveyance drive means driving, when the set print speed is higher than a standard print speed, said sheet conveying means in such a manner as to set up a sheet conveying speed matching with a highest set print speed included in the plurality of print speeds or driving, when said set print speed is lower than said standard print speed, said sheet conveying means in such a manner as to set up a sheet conveying speed matching with said standard speed.

5. A sheet feeding device as claimed in claim **4**, further comprising:

leading edge sensing means positioned on a transport path between said registering means and said sheet conveying means for sensing the leading edge of the sheet; and

control means for controlling, in response to a signal output from said leading edge sensing means, said sheet conveyance drive means such that the leading edge of the sheet abuts against said registering means and forms a preselected loop.

6. A sheet feeding device as claimed in claim **4**, wherein said pressing means comprises a press drum having substantially a same outside diameter as said ink drum and pressed against said ink drum relative to said ink drum during printing.

7. A sheet feeding device for a printer comprising an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, pressing means pressed against said ink drum relative to said ink drum with the intermediary of a sheet, registering means for feeding a leading edge of the sheet toward a print position between said ink drum and said pressing means, and a bank sheet feeding section for conveying the sheet toward said registering means, said sheet feeding device comprising:

bank registering means included in said bank sheet feeding section independently of said registering means for feeding the leading edge of the sheet toward said registering means;

bank sheet conveying means for feeding the leading edge of the sheet toward said bank registering means such that said leading edge of said sheet abuts against said bank registering means and forms a loop;

bank sheet conveyance drive means independent of a driveline assigned to said ink drum for driving said bank sheet conveying means; and

print speed setting means for setting a print speed such that said ink drum rotates in accordance with a set print speed included in the plurality of print speeds;

said bank sheet conveyance drive means driving said bank sheet conveying means in such a manner as to set up a constant sheet conveying speed without regard to the set print speed set via said print speed setting means.

8. A sheet feeding device as claimed in claim **7**, further comprising:

bank leading edge sensing means positioned on a transport path between said bank registering means and said bank sheet conveying means for sensing the leading edge of the sheet; and

control means for controlling, in response to a signal output from said bank leading edge sensing means, said bank sheet conveyance drive means such that the leading edge of the sheet abuts against said bank registering means and forms a preselected loop.

9. A sheet feeding device as claimed in claim **7**, wherein said pressing means comprises a press drum having substantially a same outside diameter as said ink drum and pressed against said ink drum relative to said ink drum during printing.

10. A sheet feeding device as claimed in claim **9**, further comprising bank registration timing sensing means mounted on said press drum for determining a timing for said bank registering means to feed the leading edge of the sheet toward said registering means.

11. A sheet feeding device as claimed in claim **10**, further comprising:

bank registration drive means for driving said bank registering means: and

bank registration drive control means for controlling, in response to a signal output from said bank registration timing sensing means, said bank registration drive means for driving the leading edge of the sheet toward said registering means.

12. A sheet feeding device as claimed in claim **9**, further comprising:

bank sheet feeding means for feeding the leading edge of the sheet from a bank tray to said bank registering means; and

bank sheet feed timing sensing means mounted on said press drum for determining a timing for said bank registering means to feed the leading edge of the sheet toward said registering means.

13. A sheet feeding device as claimed in claim **12**, further comprising:

bank sheet feed drive means for driving said bank sheet feeding means; and

bank sheet feed drive control means for controlling, in response to a signal output from said bank sheet feed timing sensing means, said bank sheet conveyance drive means for feeding the leading edge of the sheet toward said bank registering means.

14. A sheet feeding device for a printer comprising an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, pressing means pressed against said ink drum relative to said ink drum with the intermediary of a sheet, registering means for feeding a leading edge of the sheet toward a print position between said ink drum and said pressing means, and a bank sheet feeding section for conveying the sheet toward said registering means, said sheet feeding device comprising:

bank registering means included in said bank sheet feeding section independently of said registering means for feeding the leading edge of the sheet toward said registering means;

bank sheet conveying means for feeding the leading edge of the sheet toward said bank registering means such that said leading edge of said sheet abuts against said bank registering means and forms a loop;

bank sheet conveyance drive means independent of a driveline assigned to said ink drum for driving said bank sheet conveying means; and print speed setting means for setting a print speed such that said ink drum rotates in accordance with a set print speed included in the plurality of print speeds;

said bank sheet conveyance drive means driving, when the set print speed is higher than a standard print speed, said bank sheet conveying means in such a manner as to set up a sheet conveying speed matching with said set print speed or driving, when said set print speed is lower than said standard print speed, said bank sheet conveying means in such a manner as to set up a sheet conveying speed matching with said standard print speed.

15. A sheet feeding device as claimed in claim **14**, further comprising:

bank leading edge sensing means positioned on a transport path between said bank registering means and said bank sheet conveying means for sensing the leading edge of the sheet; and

control means for controlling, in response to a signal output from said bank leading edge sensing means, said bank sheet conveyance drive means such that the leading edge of the sheet abuts against said bank registering means and forms a preselected loop.

16. A sheet feeding device as claimed in claim **14**, wherein said pressing means comprises a press drum having substantially a same outside diameter as said ink drum and pressed against said ink drum relative to said ink drum during printing.

17. A sheet feeding device as claimed in claim **16**, further comprising bank registration timing sensing means mounted on said press drum for determining a timing for said bank registering means to feed the leading edge of the sheet toward said registering means.

18. A sheet feeding device as claimed in claim **17**, further comprising:

bank registration drive means for driving said bank registering means; and

bank registration drive control means for controlling, in response to a signal output from said bank registration timing sensing means, said bank registration drive means for driving the leading edge of the sheet toward said registering means.

19. A sheet feeding device as claimed in claim **16**, further comprising:

bank sheet feeding means for feeding the leading edge of the sheet from a bank tray to said bank registering means; and

bank sheet feed timing sensing means mounted on said press drum for determining a timing for said bank registering means to feed the leading edge of the sheet toward said registering means.

20. A sheet feeding device as claimed in claim **19**, further comprising:

bank sheet feed drive means for driving said bank sheet feeding means; and

bank sheet feed drive control means for controlling, in response to a signal output from said bank sheet feed timing sensing means, said bank sheet conveyance drive means for feeding the leading edge of the sheet toward said bank registering means.

21. A sheet feeding device for a printer comprising an ink drum rotatable at a variable speed in accordance with any one of a plurality of print speeds with a master wrapped therearound, pressing means pressed against said ink drum relative to said ink drum with the intermediary of a sheet, registering means for feeding a leading edge of the sheet toward a print position between said ink drum and said pressing means, and a bank sheet feeding section for conveying the sheet toward said registering means, said sheet feeding device comprising:

bank registering means included in said bank sheet feeding section independently of said registering means for feeding the leading edge of the sheet toward said registering means;

bank sheet conveying means for feeding the leading edge of the sheet toward said bank registering means such that said leading edge of said sheet abuts against said bank registering means and forms a loop;

bank sheet conveyance drive means independent of a driveline assigned to said ink drum for driving said bank sheet conveying means; and

print speed setting means for setting a print speed such that said ink drum rotates in accordance with a set print speed included in the plurality of print speeds;

said bank sheet conveyance drive means driving, when the set print speed is higher than a standard print speed, said bank sheet conveying means in such a manner as to set up a sheet conveying speed matching with a highest set print speed included in the plurality of print speeds or driving, when said set print speed is lower than said standard print speed, said bank sheet conveying means in such a manner as to set up a sheet conveying speed matching with said standard print speed.

22. A sheet feeding device as claimed in claim **21**, further comprising:

bank leading edge sensing means positioned on a transport path between said bank registering means and said bank sheet conveying means for sensing the leading edge of the sheet; and

control means for controlling, in response to a signal output from said bank leading edge sensing means, said bank sheet conveyance drive means such that the leading edge of the sheet abuts against said bank registering means and forms a preselected loop.

23. A sheet feeding device as claimed in claim **21**, wherein said pressing means comprises a press drum having substantially a same outside diameter as said ink drum and pressed against said ink drum relative to said ink drum during printing.

24. A sheet feeding device as claimed in claim **23**, further comprising bank registration timing sensing means mounted on said press drum for determining a timing for said bank registering means to feed the leading edge of the sheet toward said registering means.

25. A sheet feeding device as claimed in claim **24**, further comprising:

bank registration drive means for driving said bank registering means; and

bank registration drive control means for controlling, in response to a signal output from said bank registration timing sensing means, said bank registration drive means for driving the leading edge of the sheet toward said registering means.

26. A sheet feeding device as claimed in claim **23**, further comprising:

bank sheet feeding means for feeding the leading edge of the sheet from a bank tray to said bank registering means; and

bank sheet feed timing sensing means mounted on said press drum for determining a timing for said bank registering means to feed the leading edge of the sheet toward said registering means.

27. A sheet feeding device as claimed in claim **26**, further comprising:

bank sheet feed drive means for driving said bank sheet feeding means; and

bank sheet feed drive control means for controlling, in response to a signal output from said bank sheet feed timing sensing means, said bank sheet conveyance drive means for feeding the leading edge of the sheet toward said bank registering means.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,298,778 B1

DATED : October 9, 2001
INVENTOR(S) : Takayuki Onodera et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1,
Line 31, please delete "in"; and
Line 49, please change "damper" to -- clamper --.

Column 4,
Line 33, please change "damper" to -- clamper --.

Column 5,
Lines 11, 57 and 65, please change "damper" to -- clamper --.

Column 6,
Line 17, please delete "a";
Line 28, please change "damper" to -- clamper --; and
Line 33, please delete first occurrence of "direction".

Column 8,
Line 32, please change "nitrite" to -- nitrile --.

Column 10,
Line 14, please change "under lying" to -- underlying --.

Column 11,
Line 11, please change "2." to -- 2, --.

Column 16,
Line 55, please change "be low" to -- below --.

Column 17,
Paragraph beginning at line 28, connect with previous paragraph after "201.".

Column 21,
Line 6, please change "i s" to -- is --.

CERTIFICATE OF CORRECTION

PATENT NO. : 6,298,778 B1
DATED : October 9, 2001
INVENTOR(S) : Takayuki Onodera et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 25,
Lines 41-42, delete and insert the following -- the upper sheet feeding section via the input port and receive therefrom ON/OFF signals relating to the upper and lower limit positions of the upper tray 143. Likewise, the controller 148 is electrically connected to the upper limit sensor 139 and lower limit sensor 140 associated with the lower sheet feeding section via the input port and receive therefrom ON/OFF signals relating to the upper and lower limit positions of the lower tray 145. With the signals received from the sensors 139 and 140, the controller 148 controls the lower up-down motor 142.

The controller 148 is electrically connected to the bank sheet feed motor 107 via the output port. Assume that the sheet P is fed from the upper sheet feeding section 201, and that the print speed input on the DOWN key 96a or the UP key 96b is higher than the standard speed (fourth or fifth speed). Then, in response to a signal representative of the input print speed and transferred from the printer sheet feed controller 88, the controller 148 drives the bank sheet feed motor 107 in the forward direction such that the separation roller 32 and pickup roller 30 of the sheet feeding means 29-1 convey the sheet P at a speed matching with the input print speed. Assume that the input print speed or the automatically set print speed is lower than the standard speed (third, second or first speed or trial print speed). Then, in response to a signal representative of the above speed and transferred from the printer sheet feed controller 88, the controller 148 drives the motor 107 in the forward direction such that the above separation roller 32 and pick roller 30 convey the sheet P at a speed matching with the third or standard speed. --

Column 26,
Delete lines 5-38, and insert the following -- Then, in response to the output of the registration sensor 135, the controller 148 drives the motor 107 in the reverse direction. The motor 107 causes the leading edge of the sheet P fed by the intermediate rollers 118a and 118b to abut against the registration rollers 106a and 106b and form a preselected loop. --

Column 27,
Line 53, please change "Da." to -- Da , --.

Column 28,
Line 14, please change "of" to -- off --.

CERTIFICATE OF CORRECTION

PATENT NO. : 6,298,778 B1
DATED : October 9, 2001
INVENTOR(S) : Takayuki Onodera et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 33,
Line 1, please insert -- is -- between "printing" and "acceptable";
Line 19, please change "lading" to -- leading --; and
Line 28, please delete first occurrence of ")".

Column 34,
Delete lines 35-38, and insert the following -- routine beings with a step S30 of FIG. 30. The following description will concentrate on the third, second or first print speed or the trial print speed lower than the standard speed and set by the operator on the key 96 or automatically set. The main motor 150 drives the ink drum 1 and press drum 20 at a speed matching with the above set print speed.

First, the tray 143 of the upper sheet feeding section 201 or the tray 145 of the lower sheet feeding section 202 and a paper size thereof are selected and set on the sheet size key 98 and set key 95 or automatically set. Whether or not the tray 143 of the upper sheet feeding means 201 is selected is determined (step S30). If the answer of the step S30 is NO, the lower up-down motor 142 causes the tray 145 to rise until the top of the sheet stack P on the tray 145 reaches the sheet feed position, as determined by the lower limit sensor 139 (step S31). In this condition, the lower sheet feeding section 202 is ready to feed the sheet P thereof. It is to be noted that when the tray 145 of the lower sheet feeding section 202 and the sheet size thereof are selected and set either manually or automatically, the sheet size of the tray 145 is sensed by the sensor group 50-2 beforehand. This step, however, will not be described specifically in order to avoid redundancy.

Whether or not the press drum 20 is located at its home position is determined (step S32). Specifically, when the press drum 20 reaches the angular position θ' of 0°, the interruptor 70 interrupts the optical path of the bank sheet feed start sensor 66 (YES, step S32). The resulting ON signal output from the sensor 66 is sent to the printer sheet feed controller 88. In response, the controller 88 informs the bank sheet feed controller 148 of the turn-on of the sensor 66 by serial communication (step S33). --

Column 34, line 63 through Column 35, line 33,
Delete and insert the following -- the vertical transport path RZ. At the same time, the sheet feeding means 29-2 starts picking up the top sheet S. More specifically, the drive mechanism 125B operates as described with reference to FIG. 16 with the result that the separation roller 32 and pickup roller 30 of the sheet feeding means 29-2 are rotated clockwise in FIG. 16 (counterclockwise in FIG. 15). As a result, only the top sheet P is paid out from the tray 145 in the direction X1 (step S37). --

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,298,778 B1
DATED : October 9, 2001
INVENTOR(S) : Takayuki Onodera et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 40,
Line 65, please change "3a" to -- 33a --.

Column 41,
Line 28, please change "form" to -- from --; and
Line 41, please change "he" to -- the --.

Column 45,
Line 18, please change "placed" to -- place --.

Column 47,
Line 59, please change "form" to -- from --.

Column 49,
Line 35, please change "photointrrupter" to -- photointerrupter --.

Signed and Sealed this

Twenty-ninth Day of October, 2002

Attest:

JAMES E. ROGAN

Attesting Officer

Director of the United States Patent and Trademark Office